U.S. Army Research Institute
for the Behavioral and Social Sciences

Research Report 1793

Command Group Training in the Objective Force

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July 2002

U.S. Army Research Institute for the Behavioral and Social Sciences

A Directorate of the U.S. Total Army Personnel Command

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Research accomplished under contract
for the Department of the Army

Human Resources Research Organization
Northrop Grumman Information Technology
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NOTICES

REPORT DOCUMENTATION PAGE

1. REPORT DATE (dd-mm-yy)	2. REPORT TYPE	3. DATES COVERED (from. . . to)
July 2002	Final	4 September 01 – 4 March 02

4. TITLE AND SUBTITLE Command Group Training in the Objective Force	5a. CONTRACT OR GRANT NUMBER DASW01-99-D-0012 DO. 0012
	5b. PROGRAM ELEMENT NUMBER 0603007A
6. AUTHOR(S) J. R. Gossman (HumRRO); Billy L. Burnside (U.S. Army Research Institute); Michael R. Flynn, Bud Dannemiller (Northrop Grumman Information Technology); and Rebecca P. Mauzy (L-3 Communications)	5c. PROJECT NUMBER A792
	5d. TASK NUMBER 205
	5e. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Human Resources Research Organization (HumRRO) 66 Canal Center Plaza Alexandria, VA 22314 U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) Attn: TAPC-ARI-IK 2423 Morande Street Fort Knox, KY 40121 Northrop Grumman Information Technology 1500 PRC Drive Suite 350 McLean, VA 22101 L-3 Communications (L3 Comm) Link Simulation and Training 13665 Dulles Technology Drive Herndon, VA 20171	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Research Institute for the Behavioral and Social Sciences ATTN: TAPC-ARI-IK 5001 Eisenhower Avenue Alexandria, VA 22333-5600	10. MONITOR ACRONYM ARI
	11. MONITOR REPORT NUMBER Research Report 1793

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
Contracting Officer's Representative: Dr. Billy L. Burnside

14. ABSTRACT *(Maximum 200 words)*:
As part of future force development, the U.S. Army has begun a transformation to an Objective Force capable of achieving full-spectrum dominance in all future conflicts. This transformation will require changes in training, particularly the training of teams. Objective Force teams will likely consist of small groups of individuals (and probably robots or intelligent agents) and will have new and modified performance requirements leading to unique training needs. Teams will conduct training continuously using portable devices and training support capabilities embedded in their vehicles. Meeting these sorts of team training requirements is likely to require new training tools and techniques. This project collected and analyzed information related to Objective Force Unit of Action command groups, and, based on the analyses, developed training requirements for and identified an approach to training teams that fully supports training anytime, anywhere using operational equipment. A discussion of future research and development issues is also provided. The results of this project can benefit those involved in further definition and development of the training requirements, particularly team training requirements, for the transformation to the Objective Force.

15. SUBJECT TERMS

Objective Force	Future Combat Systems	Training	Unit of Action
Embedded training	Training Exercise Support System	Team training	UA Battalion
Command group	UA Cell	UA Team	

SECURITY CLASSIFICATION OF			19. LIMITATION OF ABSTRACT	20. NUMBER OF PAGES	21. RESPONSIBLE PERSON (Name and Telephone Number)
16. REPORT	17. ABSTRACT	18. THIS PAGE			
Unclassified	Unclassified	Unclassified	Unlimited	72	Dr. Billy L. Burnside 502-624-3450

NSN 7540-01-280-5500 Standard Form 298

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June 2002

Army Project Number
20363007A792

Personnel, Performance
and Training

FOREWORD

The U.S. Army has initiated transformation to an Objective Force designed to be responsive, deployable, agile, versatile, lethal, survivable, and sustainable to meet dynamic future requirements. The training of soldiers and leaders is key to the success of this transformation, particularly the training of teams. For many years the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) has been a leader in the development of innovative team training techniques and tools. For example, ARI's Armored Forces Research Unit (AFRU) at Fort Knox, KY has developed prototype structured programs for training small units and command groups (commanders and primary staff personnel). Available training techniques and tools need to be adapted and expanded to support the training of Objective Force teams.

This report provides the underpinnings for a research and development program addressing innovative training and performance support for Objective Force teams, with a focus on command groups. It identifies selected Objective Force training requirements and an initial approach for addressing them. This report was prepared as part of Work Package 212, "Unit Training Technologies for Future Forces." The relevant requirements document is a Memorandum for Record between the Chief, AFRU and Project Manager, Army Transformation Office, Defense Advanced Research Projects Agency, entitled "Future Combat Systems Command and Control Experiments," dated October 18, 2001.

The results of this effort were briefed to representatives of the U.S. Army Armor Center (USAARMC) on January 17, 2002, and were provided to representatives of the U.S. Army Training and Doctrine Command (TRADOC) on February 7, 2002. The requirements and approach identified should be highly useful to personnel in USAARMC, TRADOC, and other agencies responsible for developing a comprehensive training support system for the Objective Force.

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ACKNOWLEDGMENTS

The authors wish to acknowledge the assistance of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) in the completion of this project. In particular, we recognize Dr. James Lussier, ARI Armored Forces Research Unit, and Dr. Kathleen Quinkert, Chief of the ARI-Scientific Coordination Office at U.S. Army Training and Doctrine Command Headquarters.

COMMAND GROUP TRAINING IN THE OBJECTIVE FORCE

EXECUTIVE SUMMARY

Research Requirement:

As part of future force development, the U.S. Army has begun a transformation to an Objective Force capable of achieving full-spectrum dominance in all future conflicts. The transformation to the Objective Force will require changes in doctrine, leader development, organization, and soldiers, as well as in materiel. A key area of concern will be training, particularly the training of teams. Objective Force teams will likely consist of small groups of individuals (and probably robots or intelligent agents). One type of team will be the command group, which will probably be smaller than legacy force staffs and will include vertical teams consisting of leaders across echelons. Command groups will have new and modified performance requirements leading to unique training needs; they will likely be distributed during operations as well as during training with reduced opportunity for face-to-face communication; and, because they will rely much more heavily on information networks and common operating pictures during operations, they will need to be confident and proficient in their use. They will need to be proficient at commanding and controlling robotic and sensor elements and at integrating information from these various sources rapidly. Command groups will conduct training continuously, including just prior to and during deployment using portable devices and training and performance support capabilities embedded in their vehicles. Meeting these sorts of training requirements is likely to require new training tools and techniques. A general integrated approach to future command group training needs to be designed so that needed training methods and technologies can be identified for high-priority research and development. These needs provide the basis for the present project.

Procedure:

Initial project activities consisted of identifying and obtaining materials relevant to the project objectives. The vast majority of information is still under development, so many of the materials examined were draft and preliminary copies. In addition, the project staff had access only to unclassified materials. Throughout the project, the staff made its "best guess" as to how future forces would be organized based on information at hand and on the collective knowledge and experience of the staff members. Each member of the project staff gathered information independently by conducting Internet searches, and by reviewing current military and training-related periodicals.

Information analysis was conducted based on the individual skills and expertise of the project staff, which had an equal mix of military subject matter expertise and human performance development expertise. This analysis consisted of categorizing information, identifying consistencies and inconsistencies, and establishing a more and more detailed understanding of how future combat forces will be organized and will operate. Once the project staff achieved a comfortable level of understanding, it began to develop notional organizational and operational models that led to identification of training requirements, particularly for

command groups, identification of exercise types for future command group training, and the proposed approach to command group training.

Two in-progress reviews were conducted. These allowed the project staff to fine-tune the emerging findings and the comprehensive training approach. Project staff also solicited feedback on the lists of command group training requirements from military subject matter experts who were more or less familiar with Objective Force and Future Combat Systems plans and requirements. Modifications to the lists were made based on this feedback.

Findings:

The project produced several outcomes related to the stated needs. An examination of the key differences between legacy forces and the Objective Force is provided along with the role of training in the Objective Force environment. Team training requirements for command group and non-command group collective tasks are also presented. An approach to team training in the form of a Training Exercise Support System is described in terms of its operation and organization, its fielding, its future benefits, and a list of exercise types that it supports. Finally, a discussion of future research and development issues is provided.

Utilization of Findings:

The results of this project can benefit those involved in further definition and development of the training requirements, particularly command group training requirements, for the transformation to the Objective Force. One approach or mechanism for supporting projected command group training needs is presented in detail and can serve as a starting point for development of future training support systems. In addition, the research and development issues provide direction for future work that will assist the Army in achieving its stated goals for the Objective Force.

COMMAND GROUP TRAINING IN THE OBJECTIVE FORCE

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COMMAND GROUP TRAINING IN THE OBJECTIVE FORCE

Introduction

In the first two decades of the twenty-first century, the U.S. Army will undertake a transformation as significant as any previously undertaken in its two hundred twenty-five plus year history. While this transformation is in response to the way future conflicts are likely to be fought as well as to the changes in the missions the Army will face, it is equally in response to the changes in technology that characterized the last quarter of the twentieth century, especially in the areas of information gathering, processing, and dissemination. Chief of Staff of the Army, General Erik Shinseki (2000) has recently characterized the need for transformation as follows:

> Our legacy Army's warfighting prowess today is assembled around two force characteristics – heavy and light: magnificent heavy forces that are well equipped for war but difficult to deploy strategically; and magnificent light forces that can respond rapidly and are well suited for stability and support operations but lack staying power against heavy mechanized forces. Our forces must be capable of building sustained momentum in spite of the gap between these two operational forces. What we require is greater lethality, survivability, and deployability all across the force. The infusion of these capabilities throughout the force will also increase our versatility and agility for full-spectrum operations. Our forces must be able to dominate the full spectrum of military operations – to make the transition from military operations other than war to warfighting without a loss in momentum (p. 23).

This transformation is an integral part of the Joint Vision 2020 (Joint Chiefs of Staff [JCS[1]], 2000) which concludes that "full spectrum dominance implies that U.S. forces are able to conduct prompt, sustained, and synchronized operations with combinations of forces tailored to specific situations and with access to and freedom to operate in all domains – space, sea, land, air, and information" (p. 6). The Army's role and success in achieving full-spectrum dominance will rest largely in its transformation to the Objective Force.

The transformation to the Objective Force will require changes in doctrine, leader development, organization, and soldiers as well as in materiel. A key area of concern will be training, particularly the training of teams. While there will be numerous configurations of individuals, robots and intelligent agents that will comprise different types of Objective Force teams, one specific type is the command group upon which this report focuses. Command groups will exist at all echelons, will probably be smaller than legacy force staffs, and will include vertical command groups consisting of leaders across echelons. Objective Force command groups will have new and modified performance requirements leading to unique training needs. Command groups will likely be distributed during operations as well as during training with reduced opportunity for face-to-face communication, and because they will rely much more heavily on information networks and common operating pictures[2] (COPs) during operations, they will need to be confident and proficient in their use. They will need to be proficient at commanding and controlling robotic and sensor elements and at integrating information from these various sources rapidly. Command groups will likely conduct training

[1] A list of all acronyms used in this report is included in Appendix A.
[2] Also referred to as common relevant operating picture (CROP).

continuously, including just prior to and during deployment, using portable devices and training support, and other performance support capabilities embedded in their vehicle platforms and equipment. Meeting these sorts of training needs is likely to require new training tools and techniques. A general integrated approach to future command group training should be designed so that needed training methods and technologies can be identified for high-priority research and development. The purpose of this report is to identify future command group training needs as well as an approach and associated technologies for addressing those needs.

Background

In order to provide a comprehensive picture of the role command groups will play in the future forces, it is necessary to understand the transformation that is underway among all forces, and to examine how that transformation will occur in the Army. To accomplish this, a fairly extensive background section is provided.

The Department of the Army (DA), in a recent White Paper (DA, 2001a), has described the conceptual basis for the development of the Objective Force and laid the groundwork for its operation and organization. The Objective Force is designed to be organized, manned, equipped, and trained to be more strategically responsive, deployable, agile, versatile, lethal, survivable, and sustainable across the full spectrum of operations from Major Theater Wars to Small-Scale Contingencies to Homeland Security. Objective Force units will be capable of rapid deployment anywhere in the world and of conducting simultaneous, distributed and continuous combined arms, air-ground operations throughout the battlespace. The Objective Force will likely be organized hierarchically, although the use and power of distributed command and control (C2) systems to provide a common situational understanding may compress strategic, operational, and tactical echelons. Tactical units will cover much larger geographic areas than their counterparts in the legacy force, and all units will have instantaneous access to information through networked command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) systems. In fact, Shinseki (2001) has characterized the Objective Force as "a system of integrated capabilities – space, air, ground, direct and indirect and internetted with ...C4ISR" (p. 33). Current plans provide for fielding of the Objective Force initial operational capability by 2010 and an additional five Objective Force units by 2012 (Doty, 2002).

At the strategic level, the Objective Force will continue to fulfill the Army's primary mission: to fight and win wars and conflicts in which the U.S. is engaged. The Army will continue to serve as the primary integrating agent for other services. At the operational level, the Army will provide headquarters for joint, interagency, and multi-national forces along with operational level information superiority through intelligence, surveillance, and reconnaissance (ISR), information management (IM), and information operations (IO). At the tactical level, Objective Force units will be "optimized to win on the offensive, to initiate combat on their terms, to gain and retain the initiative, build momentum quickly and win decisively ... Objective Force units will *see first, understand first, act first, and finish decisively.* Operations will be characterized by developing situations out of contact; maneuvering to positions of advantage; engaging enemy forces beyond the range of their weapons; destroying them with precision fires; and, as required, by tactical assault at times and places of our choosing" (DA, 2001a, p. 6).

Seven characteristics will guide the development of the Objective Force as described in the White Paper (DA, 2001a) and as further elucidated in Field Manual (FM) 1 (DA, 2001b) and FM 3-0 (DA, 2001c). The Objective Force will be *responsive* – it will be organized into smaller, but more capable, formations able to exploit military and commercial lift to arrive in theater ready to fight. It will be *deployable* – capable of quickly and rapidly concentrating combat power in an operational area. Units will also be capable of enroute mission planning and rehearsal during deployment. It will be *agile* – possessing the mental and physical agility to transition rapidly among various types of operations. Agility will require leaders who are highly adaptive and mentally responsive. It will be *versatile* – inherently capable of domination at any point in the spectrum of military operations. Units will be organized for multifunctional operations incorporating combined arms capabilities at the lowest tactical levels. It will be *lethal* – every element will be capable of generating combat power and contributing decisively to the fight. It will be *survivable* – taking advantage of technologies to provide maximum protection. And, it will be *sustainable* – deploying fewer vehicles and utilizing combat service support (CSS) reach capabilities that optimize management and tracking of supplies and equipment.

Key to the success of the Objective Force will be its ability to obtain and employ information. It will operate in a network-centric environment by means of a global information grid (JCS, 2000) that will consist of a globally interconnected, end-to-end set of information capabilities, associated processes, and people to manage and provide information on demand to warfighters, policy makers, and support personnel. Information systems and equipment will allow access to the global information grid by any appropriately cleared participant. In the Objective Force, this access will be through C4ISR systems which provide leaders at all echelons the ability to achieve information superiority and situational understanding, and to establish, maintain, and distribute a COP (U.S. Army Training and Doctrine Command [TRADOC], 2001a). Objective Force C4ISR systems will be able to collect, display and disseminate a COP, execute battle command on the move, maintain situational awareness at all times, and identify schemes of maneuver and decision points. To operate effectively, C4ISR systems will be intuitive, redundant, reliable, continuous, configurable, automated, self-healing, transparent, and will reach to higher and adjacent echelons (TRADOC, 2001a).

The concept of information superiority is critical to future success of the Objective Force. It involves the operational advantage obtained from the ability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same (DA, 2001c). Information superiority will begin before forces ever arrive in theater and will continue throughout the conflict. The COP will be attained by the sharing of information across commands and will be displayed at a scale and level of detail that meets the information needs of the command at a particular echelon. It will be tailored to the user's requirements. Obtaining and employing a COP is a critical feature of the Objective Force C4ISR systems.

At the strategic level, the Objective Force will be composed of Units of Employment, roughly equivalent to legacy force divisions and above. These units will link ground and joint forces and orchestrate ground operations and will be the basis of combined arms air-ground task forces. At the tactical level, the Objective Force will consist of Units of Action (UAs) – tactical warfighting echelons roughly corresponding to legacy units at brigade and below. Maneuver

UAs will be the smallest combined arms units that can be committed independently (TRADOC, 2001b).

The backbone of the maneuver UAs will be the Future Combat Systems (FCS), sometimes referred to as the Future Combat System of Systems. The FCS will be a networked system of systems that will serve as the core building block within all maneuver UAs. The FCS will be comprised of a family of advanced, networked, space-, air- and ground-based maneuver, maneuver support, and sustainment systems that will include manned and unmanned platforms. The FCS will include suites of information technologies; reconnaissance, surveillance, and target acquisition (RSTA) networks; and battle command systems that will enable UAs to operate at high levels of synchronization.

The organizational structure of the UAs is currently under development, and there is not yet complete agreement on the organization or the specific terminology that will be used. This report assumes, for example, that the Platoon will be the lowest combined arms unit; however, some sources designate the Company. This paper will use the terminology that is being employed by the FCS Lead System Integrator (LSI) [3], although it will acknowledge other terminology currently in use particularly by TRADOC and the Defense Advance Research Projects Agency (DARPA). At the lowest echelon, there will be the UA Platoon – the smallest and most atomic organization within the UA. The notional UA Platoon illustrated in Figure 1 will consist of a suite of manned and unmanned systems, mounted and dismounted capabilities, direct and indirect fires, and ground and air sensors. It will be an organic combined arms unit and may be, for example, composed of one command and control vehicle (C2V), two robotic reconnaissance vehicles, two line-of-sight (LOS) direct fire systems, two non-line-of-sight (NLOS) and beyond-line-of-sight (BLOS) vehicles, three Land Warrior carriers, unmanned aerial vehicles (UAVs), and unmanned ground vehicles (UGVs) networked together as a single fighting system. The illustrated UA Platoon will operate in a three-dimensional 10- by 25-kilometer geographical space defined by the range of its organic weapons and sensor systems. Although the ultimate goal of the Objective Force is full-spectrum dominance, no Platoon will itself be full-spectrum capable. However, with proper augmentation from higher Units of Employment (UE) and UA elements, UAs at the highest echelon will become full-spectrum dominant.

[3] At the time this project was completed, most of the information available to the researchers was from DA, TRADOC, Defense Advance Research Projects Agency (DARPA), and other public sources. The LSI contract was not awarded until the project was nearly completed. This had two consequences. First, the terminology and organization considered during the project were different from that used in the report. Second, the vast majority of information considered addressed UAs only through Battalion level. Consequently, the report generally does not address Brigades specifically, although, in general, the findings will apply to this echelon also.

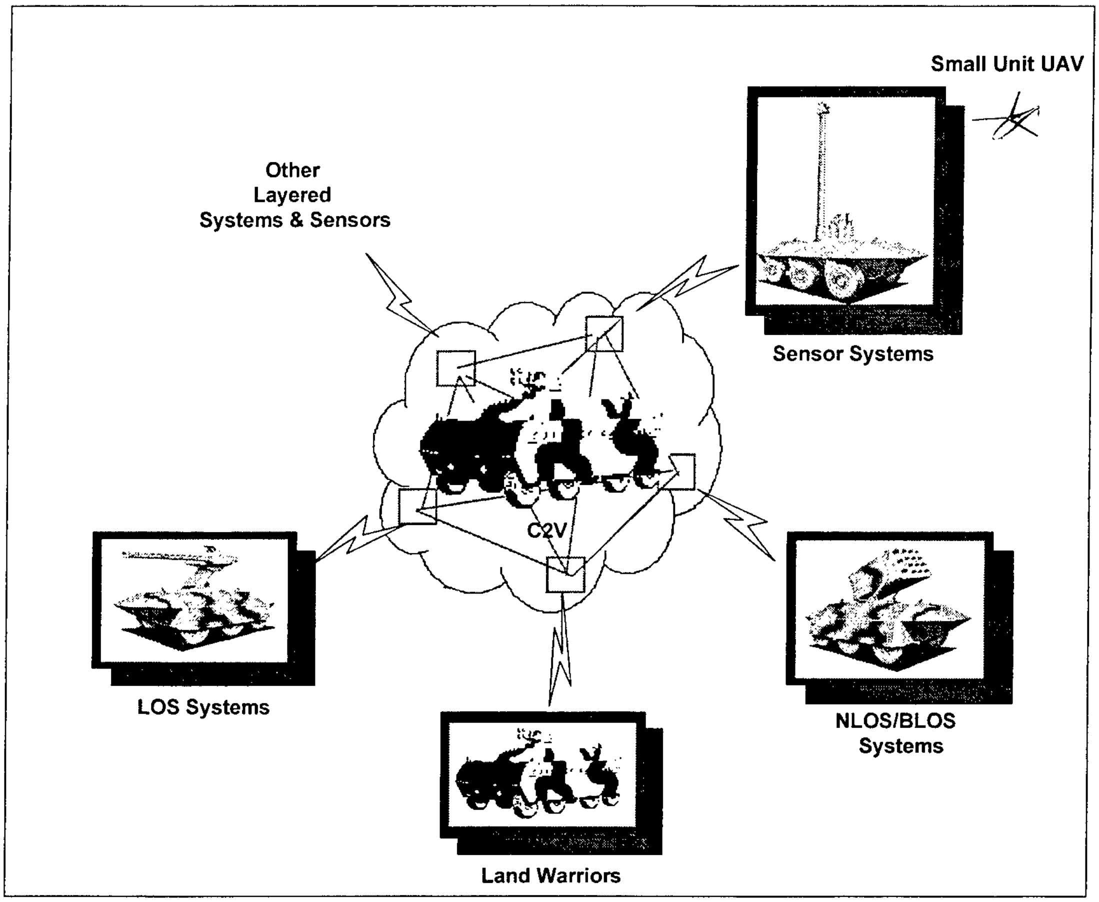

Figure 1. Prototypical maneuver Unit of Action Platoon configuration.

The UA Platoons will likely operate in tandem with one or more additional Platoons under the control of a UA Company, roughly equivalent to a Company or Troop in the legacy force. The UA Company will provide guidance, support and overwatch to Platoons and will be responsible for shaping the Platoons' battlespace and coordinating support beyond the range of the Platoon. Four to six UA Companies will comprise a UA Combat Command (Battalion), which will be responsible for rotating UA Companies in and out of action to provide continuous, uninterrupted operational pressure on opposing forces. The UA Battalion will also be responsible for pushing logistics packages, tailored to a unit's needs based on current status and future missions, to mission staging areas (MSAs). At the highest echelon, UA Battalions will be organized as a UA Brigade.[4] The UA Companies, Battalions, and Brigades are expected to be lean compared to their corresponding legacy force echelons; however, they may control additional assets not provided at the UA Platoon level. The UA Companies, for example, might own and control Distributed Common Ground System – Army (DCGS-A), and Battalions might own and control long-range tactical unmanned aerial vehicles (UAVs). Figure 2 illustrates a likely Objective Force UA organizational structure, and, as shown in Figure 3, UAs will have

[4] The TRADOC and DARPA terminology for UA echelons consists of UA Cells at the lowest level, UA Teams at the next level, UA Battalions at the next level, and UA Brigade (or simply Unit of Action) at the next level.

much larger footprints than their equivalent legacy force units. The UA Battalions, for example, may cover an area of operations (AO) as large as 300 kilometers.

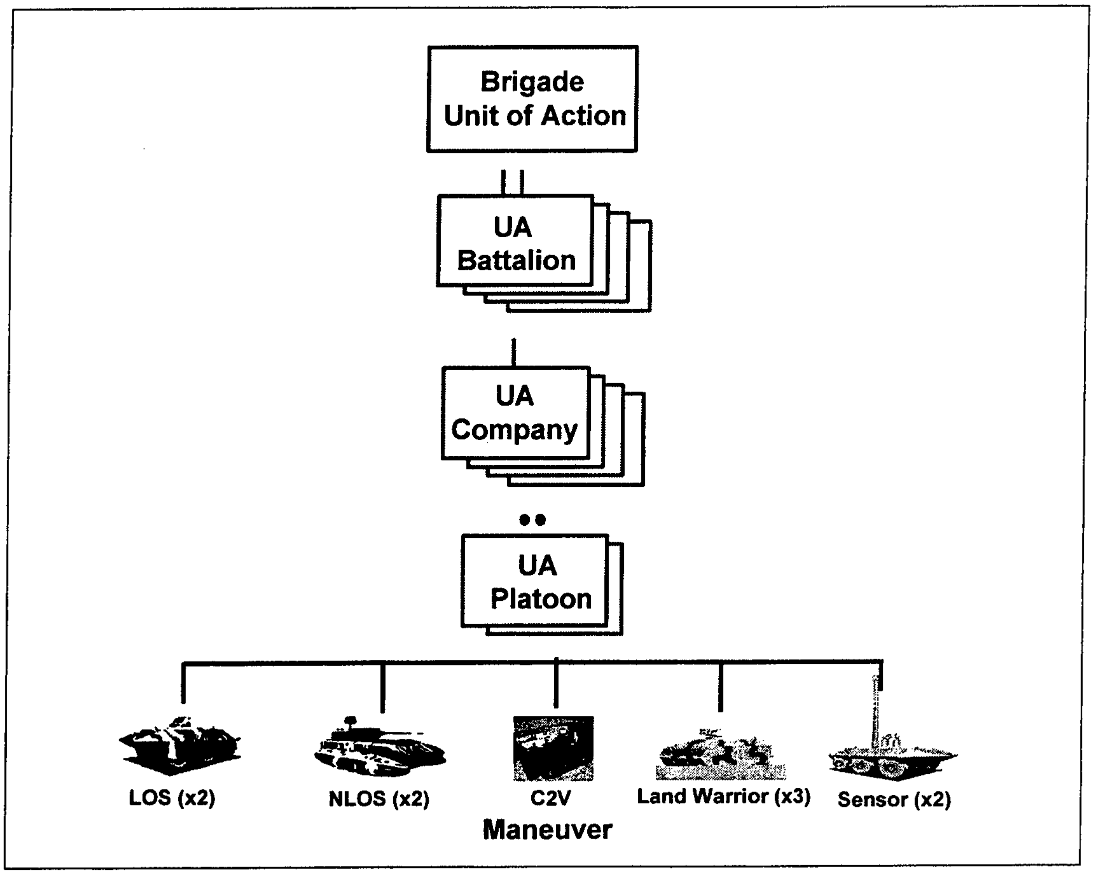

Figure 2. Objective Force organizational structure.

Manning requirements for units that will comprise echelons within UAs are currently under development. Current research being conducted by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) and DARPA, for example, is examining command group requirements. Although the exact structure of FCS command groups has not yet been determined, it may be close to that shown in Figure 4.[5] The command group for the UA Platoon may consist of four members, all of whom could operate from the UA Platoon C2V. For a UA Platoon such as the one shown previously, the four positions might include the leader, an indirect fires person, a direct fires person, and a sensors and intelligence person. These correspond to the functions around which the maneuver platoon is built. At the UA Company, the command group might consist of six to eight people operating from two C2V platforms. In addition to the commander and a supporting fires person or persons, the UA Company command group could

[5] The information on UA structure presented in this report is based on the best available information from TRADOC, DARPA, ARI and other relevant sources at the time this report was written. To satisfy project requirements, assumptions about command group structure and organization were made based on this information and on the knowledge and experience of the project staff.

also have ISR and IM[6] people. At the UA Battalion echelon, the command group might consist of eight to 12 people operating from a command post (CP) that could be fixed or mobile. The UA Battalion level is the first echelon at which specific command group responsibility for IO, CSS and joint/combined coordination is likely to be introduced.[7] The UA Brigade will likely resemble the UA Battalion in its make up, although it will be somewhat larger and will probably operate from a fixed CP.

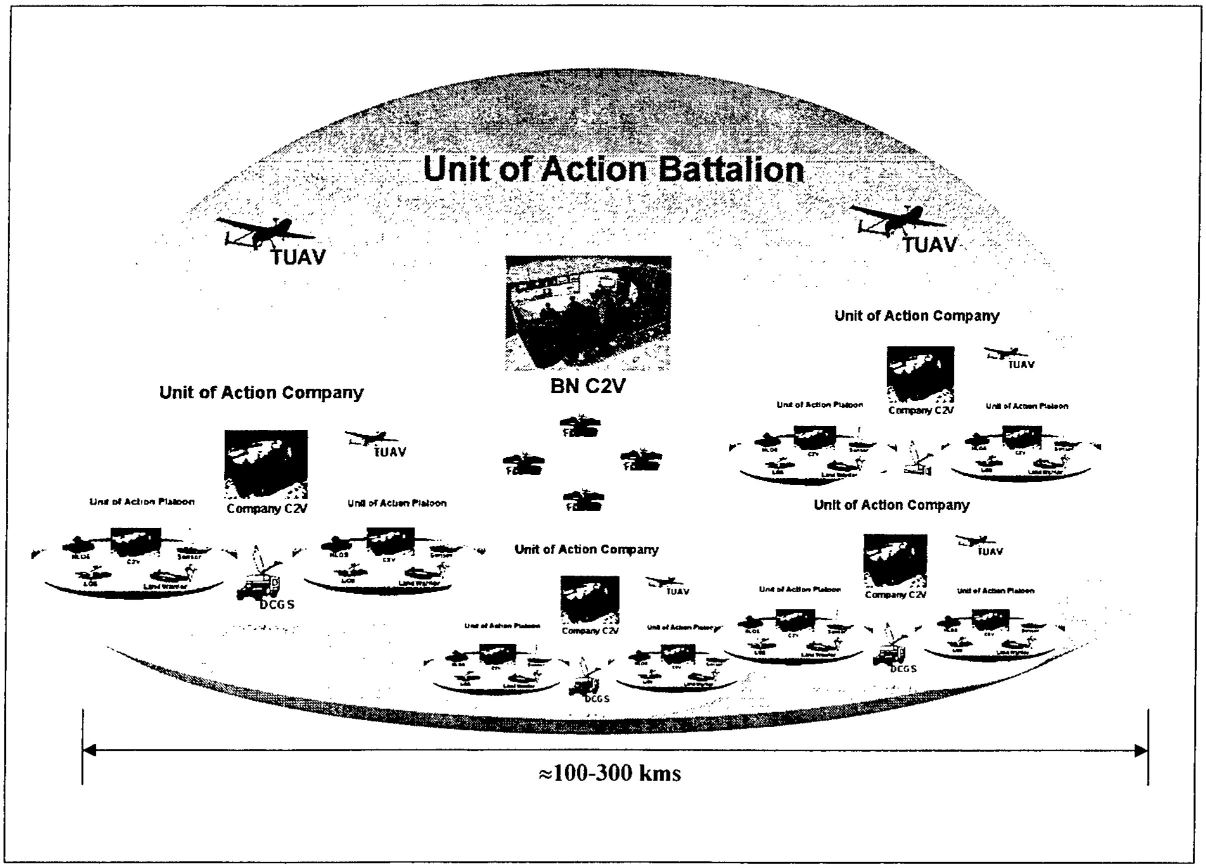

Figure 3. Prototypical disposition of a Unit of Action.

As described above, meeting general team training requirements for the Objective Force, including training of command groups, will likely require new approaches and methodologies. Training management tools will be required to determine when team members are ready to fully utilize the C4ISR network, the exercise or exercise sets (including gates) the team is ready to complete, modifications to exercises required for upcoming missions, and the skills and competencies that need to be emphasized. Training support tools will be needed to assess and display team performance results and to represent the activities of surrounding hostile and

[6] Information Management is defined as the provision of relevant information to the right person at the right time in a usable form to facilitate situational understanding and decision making. (DA, 2001c)
[7] As discussed previously, organizational structure continues to emerge. It is quite possible that some of the command group functions will shift up or down echelons.

friendly forces as well as missing team members. These needs provide the basis for the present project.

Command Groups

Unit of Action Platoon (4 people)

Leader
Organic and Supporting Indirect Fires and Effects
Direct Fires
Sensors and Intelligence

Unit of Action Company (6 – 8 people)

Commander
Intelligence, Surveillance, and Reconnaissance
Information Management
Supporting Fires

Unit of Action Battalion (8 – 12 people)
Commander
Intelligence, Surveillance, and Reconnaissance
Information Management
Information Operations
Combat Service Support
Joint/Combined Coordination

Figure 4. Possible command groups within Units of Action.

Project Objectives and Tasks

Two major objectives from the Statement of Work ([SOW] ARI, 2001) drove the project activities:

- To identify expected requirements for training staff, leader, and small unit teams in both the 2008 and 2015 timeframes.

- To design at least one comprehensive approach to addressing the future team training requirements identified for the 2008 and 2015 timeframes.

These objectives were addressed through completion of the following tasks:

Task 1. Identify anticipated training requirements for staff, leader, and small unit teams within the context of Objective Force UAs in both the 2008 and 2015 timeframes. This will include the identification of key technological developments expected to be available in 2008 and 2015 leading to needed parallel accomplishment of research and development on training

methods, tools, and techniques. It will also identify requirements for training management and training support, as well as techniques and tools that appear most relevant for training teams in UAs in 2008 and 2015. Task 1 will identify training requirements in terms of key expected skills and competencies for staff, leader, and unit teams in the 2008 and 2015 timeframe, and identify exercise types needed for the training media expected to be available.

Task 2. Design at least one comprehensive approach for addressing the training requirements identified in Task 1. The training approach will integrate training media and capabilities expected to be available in 2008 and 2015 and will be designed in sufficient detail to allow identification of specific training management and support tools and techniques required. It will also address training of key skills and competencies within exercise types identified in Task 1. The design of the comprehensive training approach will result in identification of high-priority areas and issues for near-term research and development in sufficient detail to allow specification of research hypotheses.

As the project proceeded, these tasks were refined somewhat with concurrence of the Contracting Officer's Representative. Primary emphasis was placed on examining requirements for command groups in the UAs, a term that had not been generally in use when the SOW was written.

Purpose and Organization of the Report

The purpose of this report is to examine future team training requirements for the Objective Force, particularly as related to UA command groups. It also describes, in somewhat less detail, the training requirements for unit (other than command group) collective tasks at the UA Platoon, UA Company, and UA Battalion levels. It presents an approach to training for command group and other collective tasks based on technological advances anticipated to be available and on future training requirements that will need to be satisfied. Finally, it presents research issues and questions that will need to be addressed in order to provide maximally effective training for future forces.

The report is organized as follows:

- Information gathering and analysis. This section describes the information gathering and analysis methods employed for the project.

- Findings. This section presents the results of the information analysis in terms of differences between legacy and future forces, the role of training in the future force environment, future training requirements, anticipated technological advances and their impact on training design, development and management, and an identification of exercise types that will support future team training.

- The Training Exercise Support System. This section presents a detailed description of a proposed Training Exercise Support System (TESS) that represents a training approach that could take full advantage of future technology advances and that should be fully responsive to future training needs.

- Future research and development directions. This section presents a description of selected research questions that may be key to developing future forces.

- Summary. This section summarizes the methodology and findings of the project.

- Appendixes A through D contain an acronym list, a list of the information sources reviewed for the project, UA collective (non-command group) tasks, and selected research and development issues, respectively.

Information Gathering and Analysis

Initial project activities consisted of identifying and obtaining materials relevant to the project objectives[8]. Since Objective Force and FCS concepts are in early stages of development, much of the material is in flux, and many of the materials examined were draft and preliminary copies. In addition, project personnel had access only to unclassified materials. And, while it is true that there is a wealth of information available electronically on, for example, the Objective Force, FCS, and probable technological advances, it is also true that the information is not always in agreement, and, in fact, is sometimes contradictory. Throughout the project, members of the project staff made their "best guess" as to how future forces would be organized based on information at hand and on their collective knowledge and experience.

Each member of the project staff gathered information independently by conducting Internet searches, and by reviewing current military and training related periodicals. This comprised the primary initial activity of the project, although the staff met frequently to discuss findings and to continue to refine the approach to collecting additional information.

Information analysis was conducted based on the individual skills and expertise of the staff members. The group had a mix of military subject matter expertise and human performance development expertise. Analysis consisted of categorizing information, identifying consistencies and inconsistencies, and establishing a more and more detailed understanding of how future combat forces will be organized and will operate. Once the staff achieved a comfortable level of understanding, they began to develop notional organizational and operational models that led to identification of training requirements, particularly for command groups, identification of exercise types for future command group training, and the proposed approach to command group training.

Several reviews were conducted during the project providing the project staff with additional information. Two in-progress reviews were conducted: one at the completion of Task 1 and one at the completion of Task 2. Both reviews provided valuable feedback, which allowed the staff to fine-tune the research findings and the comprehensive training approach. The staff also received feedback on the lists of command group training requirements from a group of military subject matter experts who were more or less familiar with Objective Force and FCS plans and requirements. Modifications to the lists were made based on this feedback.

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[8] A listing of references and materials examined for the project is included in Appendix B.

Findings

Key Differences Between Legacy Forces and Future Forces

The future force is likely to differ from today's legacy force in several key areas, and in large measure, it is the differences that lead to the identification of training requirements and that suggest the design of a training approach.

First, the types of conflicts and the nature of warfighting itself are changing. Future conflicts are likely to require rapid deployment into undeveloped theaters characterized by asymmetric threats. Conflicts will take place in complex urban environments in which hostile forces are intermingled with noncombatants. Recent incidents of this have occurred in Afghanistan where Taliban forces and friendly forces were virtually indistinguishable, and, in fact, Taliban forces often became friendly forces by overnight changes in allegiance.

Future forces will need to share information seamlessly and effortlessly. Future conflicts will involve joint operations, and very often, multi-national operations as well. This places a tremendous emphasis and demand on sharing of information in a highly effective, efficient manner. The linking of sensors, delivery systems, and effects, will take place across Services and will incorporate applicable capabilities of multi-national partners when appropriate. The key to information sharing will be interoperability. As directed in Joint Vision 2020, (JCS, 2000): "Interoperability is a mandate for the joint force of 2020 – especially in terms of communications, common logistics items, and information sharing. Information systems and equipment that enable a COP must work from shared networks that can be accessed by any appropriately cleared participant" (p. 15). For FCS units, interoperability and information sharing will be achieved by means of C4ISR systems networked through the global information grid.

Related to information sharing will be the need for future forces to achieve information superiority. The side with the better ability to obtain and process information will have a definite advantage in future conflicts. The value of information operations cannot be overstated; it could well be the decisive factor in future conflicts. Potential opponents undoubtedly think that achieving information superiority will constitute the most productive avenue to take to offset the U.S. conventional battlefield capabilities. FM 3-0 (DA, 2001c) defines information superiority as "the operational advantage derived from the ability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same" (p. 11-2). Achieving information superiority involves three components: the ability to obtain information through ISR; the ability to manage information to ensure that commanders have the information they need when they need it, and the ability to conduct information operations to protect friendly information and to disrupt the enemy's information. It will be critically important that U.S. and allied forces achieve information superiority.

Future forces will rely heavily on precision fires to the point that close combat may become a rare event. More and more of the most dangerous operations will be performed by robotic elements, which will be capable of identifying targets and executing fires to achieve greatest effect. As FM 1 (DA, 2001b) states, "In the future, the Army will see a battlefield in which

precision weaponry both demands and allows greater dispersion of forces. Increasing reliance on electronic systems for managing the fight will move even more combat into the information environment" (p. 35). The emphasis will be on massing fires, not forces, which is specified as a requirement for the Revolution In Military Affairs described by the Defense Science Board (DSB) Task Force (Braddock & Chatham, 2001). This will be accomplished by means of "widely spaced units flawlessly connected to each other and to their command structure" (p. 1). Because the emphasis will be on massing fires, future force units will be able to cover much larger geographical areas than their legacy force counterparts. As previously shown in Figure 2, for example, a UA Maneuver Platoon may cover approximately a 25 kilometer diameter circular area extending 10 kilometers into the air; UA Companies may cover as much as 50 kilometers; and UA Battalions as much as 300 kilometers.

Future forces will rely on collaborative planning[9] even down to the lowest echelons, unlike collaborative planning in the legacy force, which generally does not occur below the brigade level. This will be made possible by means of shared information networks and the increased ability to develop and disseminate a COP. The flow of information will be virtually instantaneous to all echelons resulting in simultaneous rather than sequential orders production cycles. These newly acquired capabilities will place additional requirements on commanders and other unit members who will need a broad understanding of the operational systems and tools in order to provide flexible cooperation and collaboration.

Future conflicts will likely be much more "public." As occurred in the Gulf War, and more recently in Kosovo and Afghanistan, engagements are reported almost immediately on public news agencies. This can be both a blessing and a curse to commanders. It can offer great assistance to the decision-making process; however, it also makes operations transparent to the world. Future commanders will need to be skilled in dealing with the news media in order to maximize the benefits and minimize the risks of increased public awareness.

Future forces will be capable of command and control on the move. "Objective Force commanders will be free to move about the battlespace by any means while maintaining uninterrupted access to the common operating picture and subsequent situational awareness" (TRADOC, 2001a, p. 15). Commanders will have access to networked RSTA – "manned and unmanned air and ground RSTA and remotely delivered sensors – organic at all UA echelons, linked to all shooters...Units will be able to go on mission, receive and disseminate terrain and weather information immediately throughout the area of responsibility (AOR), even while enroute to gain the 'home court advantage' at all times" (TRADOC, 2001b, p. 7). Commanders will also be able to take advantage of virtual staffs. They will be able to engage in active planning and decision-making without having to physically assemble at a CP. This will greatly facilitate the decision-making process and will also provide the capability to rehearse subordinate commanders and staff while dispersed and on the move. Staffs at higher echelons will undoubtedly be leaner since much of the logistics and CSS will be highly automated, and since there will no longer be the intensive human actions required to move information up, down, and across echelons. Information will be instantly available via the global information grid to everyone with proper clearance. Additionally, more and more decision-making is likely to occur

[9] Collaborative planning is the real-time interaction of commanders and staff at two or more echelons developing plans for a particular operation. (DA, 2001d)

at lower echelons consistent with the vision that "In making well-informed decisions at the lowest levels, Objective Force units will operate faster than current units where decisions are more centralized" (DA, 2001a, p. 8). There will no longer be a necessity for CPs to be located close to the conflict since all critical information will be available worldwide virtually instantaneously.

These are some of the operational differences that will characterize future forces, and, in general, they have one thing in common. They all involve much greater access to, and utilization of, information. Information will be the most sought-after commodity of future conflicts. This will be as true for the lowest echelons as it is for the highest. However, what this also means is that leaders at all echelons must be adept at processing this information. Leaders will need to be highly skilled at information integration, independent thought, abstraction and the use of broad and complex frames of reference (TRADOC, 2001a). Leaders will need to be adaptive and self-aware.

Training in the Future Force Environment

Although the primary focus of this report is on training of command groups, there are considerations that apply to training in general. This section will examine those considerations. The same factors that are leading to the need to transform the Army are also pushing a transformation in the way the Army will train. This doesn't mean basic training doctrine will change – the principles established in FM 25-100 (DA, 1988) and FM 25-101 (DA, 1990) will continue to apply to future training, including command group training. The Army will continue to train as it fights, that is, it will train tasks under conditions that are as close to those that will be involved in actual combat as is practical. This will still apply even though the way the Army fights might change dramatically. Commanders will continue to be the primary trainers for their units since they will be responsible for assessing their unit's proficiency, identifying training deficits, and providing the required training and resources to ensure that their unit is combat-ready at all times. Training will continue to be the most important unit activity outside of actual combat; in fact, the amounts of time units spend training will likely increase significantly. Every day a unit is not fighting should be spent training. Training will continue to be performance-oriented and task- or proficiency-based. Training development will likely continue to employ a form of the Instructional Systems Design (ISD) model it has used for years, and that has provided the Army with a decided training advantage. Training effectiveness will continue to be critically assessed through rigorous after action reviews (AARs). What will change is the way the Army trains. More and more training will be supported and delivered using actual operational systems.

Current Army policy (DA, 1987) specifies that all new systems must consider embedded training in their design and development.[10] It is entirely conceivable that the capability to support most training needs could be embedded in the FCS. However, this capability must be considered in conjunction with other system specifications and requirements. For example, it is

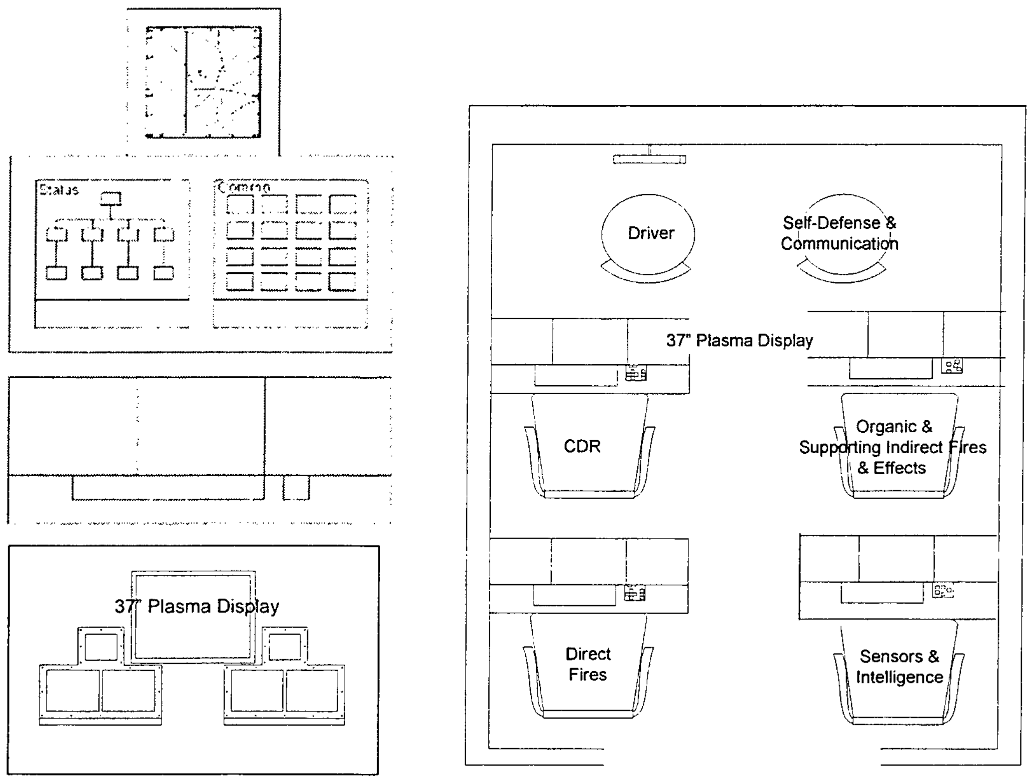
[10] In this report, a distinction is made between embedded training and an embedded training capability. Embedded training implies that the actual training content and/or specific exercises are resident in the system or platform. Embedded training capability implies that the system or platform supports training, although actual content or specific exercises may reside on the system only during a training event.

possible that "out the window" simulation capabilities could be embedded in an FCS platform; however, this could add substantially to the weight and size of the platform, particularly in the 2008 timeframe if extensive hardware (e.g., monitors) is required. This may be prohibitive. Other training capabilities might involve merely adding an additional circuit board or additional software to the onboard operational systems which is much more feasible. In addition, capabilities are likely to change substantially over time as hardware gets smaller and information processing gets more sophisticated. Whatever the case, it will be important for FCS designers to consider FCS training needs and embedded training capabilities in the near- and long-term as an integral part of total system design.

To provide a better understanding of embedded training capabilities, consider the notional layout of the C2V for the UA Platoon command group shown in Figure 5. The layout for a UA Company C2V would probably be quite similar. As displayed on the right side of Figure 5, there are four stations in addition to the driver and self-defense/communications stations. Each of these stations will have a support environment consisting of display panels, communications devices, and input/output devices (touch screens, keyboards, mice, voice recognition and generation, etc.) as shown on the left side of the figure. All stations will be fully networked and wirelessly connected to the global information grid via the on-board C4ISR network. In an operational environment, the stations will be receiving data through the C4ISR network, and the data will be displayed and presented on one or more of the components of the support environment. Actions taken by crew members will produce data which will be transmitted either internally to other crew members via the vehicle's internal network, or out to the world over the global information grid. Imagine the following scenario. The UA Platoon leader has just received an order, transmitted digitally, from the UA Company commander requesting surveillance of an area of terrain falling within the UA Platoon's AO. The UA Platoon leader sends an order to the sensor and intelligence crewman, either verbally or via his support environment, to gather surveillance data on the specified area. The sensor and intelligence crewman decides how best to conduct the surveillance and transmits a digital order to one of the Platoon's organic sensor vehicles, which happens to be fully robotic. The digital order triggers the launch of a UAV carrying a digital video camera. The UAV flies over the specified area, under the control of the sensor and intelligence crewman, and provides a continuous stream of digital video images. The images are transmitted to and picked up by the global information grid from which they are available to everyone with clearance including the sensor and intelligence crewman, the UA Platoon leader, and the UA Company commander who gave the original order. In addition, since it is a fully networked environment, the images are also available simultaneously to higher and adjacent elements all the way up through command groups located at CPs in the U.S..

It is relatively easy to envision an embedded training support capability in the FCS that would operate through the onboard C4ISR network and individual support environments. All that is required is the capability to stimulate the C4ISR network to produce the displays and communications that would occur in an actual operational situation. This could be accomplished

by means of a partially embedded training support system[11] that provides soldiers the opportunity to train using their actual equipment – not on a simulator or other device that represents or replicates their equipment. This represents a substantial difference between today and the future. As discussed in the *Objective Force C4ISR Concept* paper (TRADOC, 2001a), "The legacy force commander cannot currently use his own battle command systems to train his headquarters to fight. He must either use artificial response cells in a static simulation center or he must plan for months and spend a great deal of funds to establish interfaces between his battle command systems and outdated simulations. Without an embedded battle command training and mission rehearsal capability, the commander cannot realistically prepare for his mission or wargame his courses of action" (p. 11).



The left side displays the support environment that will be used by command group members; the right side displays the workstation locations of the command group.

Figure 5. A notional Future Combat Systems command and control vehicle.

For embedded training to work effectively in future force training, it must be an inherent component of FCS design. It must be usable and sustainable and must enable units to deploy rapidly without the need for system-specific training prior to deployment. In addition it must facilitate training using the same operational systems and controls that will be used in the FCS environment.

[11] In this instance, embedded refers to the FCS, not just to a specific vehicle or platform. Some components of the embedded system may be on the vehicle; however, others may be part of the larger FCS. In addition, there may be a non-embedded training support component (i.e., external to the FCS) that works in conjunction with the embedded component to provide the complete training capability.

Training for FCS units should be designed to involve the capability to train using actual operational systems with training support being provided by onboard systems and by external systems operating through the global information grid. (A later section of the report will discuss the external training support system in greater detail.) The FCS training capabilities underlie a number of important implications:

- Entire units, or portions of units, at any echelon will be able to train anywhere, anytime. They will not be limited by unit size, and they will not need the complex training and simulation sites required for the legacy force of today. Because the vast majority of collective training will occur in the unit's vehicles using actual operational systems, units will be able to train at home station; they will also be able to train at combat training centers (CTCs) or while being deployed, or even after deployment while in theater.

- Training will be brought to units instead of units being brought to training. Units will no longer rely on fixed institutions or simulation centers;[12] this will allow training to be delivered just in time and completely relevant to the units' current training needs. As the DSB Task Force put it, "Future training must be delivered to the individual, to units, and to joint forces, when it is needed, not in the schoolhouse after which there is time for proficiency to decay. Training must be applied over and over again as the composition of the units and joint forces changes and as skills erode over time" (Braddock & Chatham, 2001, p. 1).

- Units will train on the move as well as while stationary. This mirrors the basic command and control on the move operational capability of UAs and will be achieved through networking via the global information grid and the embedded C4ISR systems. Unlike legacy forces, future force units will not be limited to static CPs. Since the C4ISR network is also the backbone of FCS training, units will be able to train on the move including effective enroute mission planning and rehearsal.

- Training will employ a train-alert-deploy paradigm rather than the alert-train-deploy paradigm characteristic of the legacy force. Objective Force units will be multidimensional and multifunctional. They will be capable of rapid deployment in support of a wide variety of missions requiring them to have been adequately trained on those missions. When the need for deployment arises, units will be able to use mission planning and rehearsal during deployment to fine-tune their skills and knowledge to achieve maximum effectiveness as soon as they are in theater.

- Units will train using multi-echelon and joint/combined exercise scenarios. It does not matter whether higher, subordinate, adjacent or multi-national units are actually present; the training support systems will have the capability to simulate their actions with realism and fidelity such that any participating units will not know whether other units are live or simulated.

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[12] This discussion applies specifically to collective training. It may be more efficient to continue to deliver some training in simulators, particularly when there are substantial risks involved. Initial driver training or initial gunnery training are examples where potential risk might dictate training in a simulated environment.

- In a similar vein, individuals will be able to participate in collective training as if their entire unit was present. Individual soldiers will be able to train or fine-tune the individual skills and knowledge they perceive to be weak or deficient in a collective training exercise even though no other members are present. Again, this stems from the ability of the training support systems to simulate the actions of any individual member of a team just as if that member had been present.

- Individuals or groups will be able to train even when they are not in their vehicles, or even when they are not in the same location. Since the training support system will be using the same global information grid that will be used in the operational environment, all that is required is access to the grid via a device that has the capability to simulate the C4ISR network and the support environment. This could be a personal computer (PC), or by the year 2015, even a handheld personal digital assistant. As Campbell and Holden (2001) envisioned it, "Research on modeling is leading to representations of individual human performance, which should allow small groups to train without a full complement of participants. Wide-area networks and the Internet are being used to overcome the challenges of providing collective training for geographically separated team members, and linked simulations using long-haul networks are maturing to create a realistic training environment" (p.16). By 2015, this vision is likely to be realized, although necessary planning and design to achieve it should be occurring now.

- The use of artificial intelligence capabilities including intelligent agents[13] will become more and more widespread and sophisticated during the timeframe of FCS development. Significant advancements are continuously occurring in areas such as on-line tutoring and mentoring, as well as advanced help systems in which intelligent agents monitor a user's actions and offer suggestions and/or interventions where appropriate. These capabilities will be particularly important to the FCS operational environment where units will be required to process and utilize large amounts of information in relatively short timeframes. Intelligent agents can assist users in correctly interpreting information as well as in avoiding actions that are inappropriate or unnecessary.

- Distance learning methodologies will become increasingly important in the training of future forces. The Army Distance Learning Program (ADLP) is becoming an integral part of total Army training and will assume even greater importance in the future. While ADLP currently applies more to individual training, in the future it will likely apply to collective training also using methods such as collaborative Internet-based meetings and other distributed technologies.

While embedded training will be critical to training of FCS units, it must still be recognized that it is only part of the picture. There will continue to be the need to apply good, sound training development and delivery methods and techniques such as those specified by the ISD process or its successors. The Army must continue to maintain the training superiority cited by

[13] Although there are currently many definitions of intelligent agent, a useful one comes from Gilbert, et al., 1995. "Intelligent agents are software entities that carry out some set of operations on behalf of a user or another program with some degree of independence or autonomy, and in so doing, employ some knowledge or representation of the user's goals or desires."

the DSB who gave much credit to the use of CTCs[14] which provide an environment as close to actual battlefield conditions as is practical. The same task force also found that the CTCs are not being supported as well as they were five or ten years ago and recommend that this trend be reversed (Braddock & Chatham, 2001).

The Army should continue to apply an AAR/feedback system to ensure training effectiveness. And, it must find ways to make the feedback even timelier. Part of the training support systems for future training will need to examine performance feedback requirements, not only after an exercise is completed, but also even during the running of the exercise. It is quite probable, for example, that methodologies will be developed for providing intervention feedback during an exercise in which an individual's or group's active participation will be temporarily suspended and taken over by the training support system while the group or individual is provided with feedback, coaching and mentoring.

The Army should increase the capability of commanders and other trainers to tailor training to their specific needs. The efficacy of doing this has been demonstrated by a series of ARI-sponsored projects to develop the Commander's Integrated Training Tool (CITT) for the Close Combat Tactical Trainer (see Flynn, et al., 2001). These projects clearly demonstrated that commanders are capable of developing quality training exercises, often by modifying existing ones, given sufficient assistance and tools.

The Army should reexamine acquisition policies for new programs. The DSB task force noted that the Army at one time had a policy that for each development program, a training subsystem be formally designated and funded with acquisition dollars. The policy was not applied fully because, if the training subsystem was not ready, the whole system was declared not operationally ready and was not deployed. The task force "saw no plans anywhere, Service-based or joint, for fundamentally altering the training infrastructure to accommodate Joint Vision 2010/2020 warfare. As we found in the acquisition process, it appears that training is ignored when planning for the future in the tacit hope that it will solve itself. Training programs are, by and large, reactive, not proactive" (Braddock & Chatham, 2001, p. 12). The FCS program will not be successful if this is allowed to occur again. The embedding of the training support systems must be considered as part of the system design and development process, or FCS training will never live up to the capabilities described in all the specifications and all the design documents, no matter how well they are stated.

Future Combat Systems Training Requirements

In addition to examining how training likely will occur in the future force, project personnel also examined what the future force training requirements for command groups will be. Following Army doctrine that training is task-based, this examination was approached by attempting to identify what tasks the UA command groups will complete. The analysis was limited to collective tasks and further distinguished between command group tasks and other unit

[14] Although CTCs may be considered part of the institutional training network, their importance to the present discussion lies in their ability to provide a very realistic training environment coupled with excellent opposing forces and AARs. These functions need to be available regardless of whether they are provided within an institution or not.

collective tasks. It should be noted that, although the project's efforts focused on tasks, there is no reason a similar analysis could not be made focusing on group and individual competencies.

In attempting to identify command group tasks, the project staff focused on the collective actions that would be taken by the command group in their C2 capacity. This did not include other collective tasks the command group may complete that are not part of commanding and controlling the unit. Table 1 presents the results of the analysis for command group tasks broken down by echelon. For each echelon, tasks are further categorized by whether they represent a planning activity, an activity related to "see first," an activity related to "understand first," an activity related to "act first," or an activity related to training the unit.[15]

While there are tasks that are included at all three echelons (Conduct intelligence preparation of battlefield [IPB], Communicate and display information) the number of tasks required increases at each higher echelon. This reflects the fact that the UA Platoon and (to a lesser degree) the UA Company are expected to be lean organizations whose command groups are very focused on conducting combat operations, and that combat support (CS) and CSS activities are consolidated at the higher echelons.

At the UA Platoon level, the focus is on executing tasks that are directly related to the placement and movement of its elements, control of its sensors, targeting and engaging threat forces, and communicating information to higher and adjacent units. Tasks associated with CSS activities are planned and conducted by other units and monitored at the Platoon level.

At the UA Company level, there is still a significant focus on tasks that support conducting combat operations such as those mentioned above. However, at this level there are additional tasks that support planning for stability and support operations, coordinating with external units, synchronization of forces and their effects, and conducting battle damage assessment (BDA). As at the Platoon level, the Company command group only monitors CSS activities within its AO.

At the UA Battalion level, the number of command group tasks increases fairly dramatically. This is the first level of command that has a significant number of tasks associated with CS (mobility, survivability, and communications) and CSS (plan for and coordinate CSS) operations. Additionally this level is where the majority of the planning and coordination with external (joint and coalition, media, humanitarian, and native) agencies occurs. This makes the UA Battalion command group the first level responsible for coordination of all activities related to operations in the battlespace. (As discussed previously, the task analysis could easily be extended to UA Brigade; however, this was not done as part of the current project.)

[15] It is possible that some of the listed tasks will move to a higher echelon when final UA organizational decisions are made (i.e., what the lowest level for a combined arms unit will be.)

Table 1
Command Group Collective Tasks by Echelon

Unit of Action – Platoon	
Plan Conduct intelligence preparation of the battlefield (IPB) Conduct collaborative planning and decision-making Plan intelligence, reconnaissance, and surveillance (ISR) operations Develop fire plans Develop orders Plan force protection operations **See** Develop and maintain a common operating picture Develop the situation using ISR assets (out of direct contact) Control sensors and process information	**Understand** Communicate and display information (ISR handover) Communicate and display decisions and orders Develop and maintain situational awareness Conduct mission rehearsals Collect and report battle damage assessment (BDA) **Act** Command and control (C2) the platoon Control placement and movement of subordinate elements Control targeting and engagement at extended ranges Act without or beyond the scope of orders Monitor combat service support (CSS) operations **Plan, Execute, and Assess Training**

Unit of Action – Company	
Plan Conduct IPB Conduct collaborative planning and decision-making Plan ISR operations Develop fire plans Develop orders Plan force protection operations Plan combat operations Plan support operations Plan stability operations **See** Develop and maintain a common operating picture Develop the situation using ISR assets (out of direct contact) Control sensors and process information	**Understand** Determine likely enemy action Communicate and display information (ISR handover) Communicate and display decisions and orders Develop and maintain situational awareness Conduct mission rehearsals Collect BDA reports **Act** Command the company Control placement and movement of subordinate elements Control targeting and engagement at extended ranges Rapidly assess options Identify when and where the team needs to transition (adjust execution) Maintain full synchronization throughout the battlespace Act without or beyond the scope of orders Monitor CSS operations **Plan, Execute, and Assess Training**

(table continues)

Table 1 (continued)

Command Group Collective Tasks by Echelon

Unit of Action – Battalion

Plan
- Conduct IPB
- Conduct collaborative planning and decision-making
- Plan ISR operations
- Develop fire plans
- Develop orders
- Plan the cycling of available forces
- Plan mobility and survivability support operations
- Plan communications support
- Plan information operations
- Plan CSS operations
- Plan force protection operations
- Plan combat operations
- Plan support operations
- Plan stability operations
- Plan humanitarian support
- Develop media plan

See
- Develop and maintain a common operating picture
- Develop the situation using ISR assets (out of direct contact)
- Control sensors and process information

Understand
- Determine likely enemy action
- Communicate and display information (ISR handover)
- Communicate and display decisions and orders
- Develop and maintain situational awareness
- Conduct mission rehearsals
- Collect BDA reports

Act
- Command the battalion
- Coordinate maneuver to a position of advantage
- Control targeting and engagement at extended ranges
- Rapidly assess options
- Identify when and where battalion needs to transition (adjust execution)
- Maintain full synchronization throughout the battlespace
- Coordinate the cycling of available forces
- Coordinate CSS operations
- Integrate mobility and survivability support operations
- Coordinate communications support
- Integrate joint and coalition forces
- Conduct information operations
- Act without or beyond the scope of orders
- React to indirect fire
- Coordinate movement of dislocated civilians
- Establish liaison
- Transfer control of current operations between command elements
- Conduct mediation and negotiation
- Conduct ISR operations
- Coordinate humanitarian support

Plan, Execute, and Assess Training

Table 1 presents the expected training requirements for the Objective Force UA command groups. Using this list, exercises can be designed and developed that focus on training the various command groups. Appendix C contains a list, by echelon, of unit collective tasks, which will serve a similar function for development of unit exercises.

Having described the role of training and its characteristics as well as training requirements for future force UAs, the report will now examine a possible method for training command group tasks.

A Method for Training Command Group Tasks

Command group tasks are, by definition, collective tasks, and a plan for training command group tasks should recognize that learning to perform collective tasks is best accomplished through executing exercises designed to ensure practice of those tasks. Any collective task performance is comprised of the actions of the individuals making up the collective group, and the individual skills and knowledge required to support those actions can be trained by a variety of methods. Teams or groups, on the other hand, learn to perform collective tasks by practicing them together – by learning to apply their individual skills and knowledge at the correct time, in the correct sequence, in conjunction with the actions of other members of the group to produce a collective action. This is the basis for the command group training method, which consists of providing opportunities to practice performing command group tasks in a variety of situations.

Before describing the method, it will be helpful to examine training that should have already occurred prior to collective exercises. There will have been a great deal of individual training delivered in a variety of ways. There will be a need for institutional training at the individual level, although this training may or may not be delivered in classrooms. It could also be delivered via distance learning methods or other non-traditional methods including individual training embedded in systems. The important point is that each individual will have received training to a measurable level of proficiency on the individual skills and knowledge required for performance of their tasks. The command group training method assumes that this individual training has occurred (and may still be occurring).

The command group training method consists of participation in training exercises utilizing a systematic process in which exercises become progressively wider in scope and more and more realistic. This is substantially the same as the way collective training occurs in today's legacy force. Currently, staff[16] training typically occurs in either a constructive or live environment using a variety of exercise types such as map exercises, staff training exercises, and live training exercises. Command group training will also occur using a variety of exercise types that provide group members an opportunity to practice command group tasks with increasing realism both in terms of the number of participants and the overall context of the exercise.

A continuum of training events that represent increasing realism can be described based on three dimensions. The first dimension, Exercise Scope, represents the highest echelon for which an exercise is written from Platoon through Battalion. The second dimension represents the echelon of the unit members participating in training, again from Platoon through Battalion. The third dimension represents the number of members of the unit who are actually participating in the training exercise. This dimension recognizes that someone can participate in a group exercise as an individual with full realism as long as the training support system is capable of simulating the other members of the group.[17] Similarly, subsets of the command group can participate in an exercise, again with full realism. The continuum is produced by the variation of these dimensions in different combinations. Exercises can vary from a single individual participating in an exercise written for his echelon only up through an entire Battalion (including its associated Companies and Platoons) participating in an exercise written at the Battalion level.

[16] Staff training is the closest analog to command group training in the current legacy force.
[17] A later section of this report will describe such a training support system.

To clarify the command group training plan, an example will be presented. Lieutenant Jones is the leader of a UA Platoon and has completed individual training to a proficiency level required to begin command group training. In a typical situation, he would begin with a command group exercise at the platoon level as the sole live participant. The actions of all other member of the command group would be simulated. As LT Jones gains proficiency, he would bring other members of the command group (who may also have been practicing their roles individually) into the exercise until, ultimately, the entire command group is participating. As the group gains proficiency, they would select an exercise written at the Company level in which they would practice their Platoon level command group tasks, initially with the Company command group simulated, but ultimately with that command group participating live also. Following this approach, the Platoon command group would ultimately execute their command group tasks in a Battalion level exercise with all other command groups participating live. By extension, one can apply this same approach to command groups at Company and Battalion levels.

As implied, for this approach to work, there will need to be a sophisticated, intelligent, and powerful exercise support system capable of presenting the exercises and simulating the actions of the command group members not actually participating. Such a support system is the subject of the next section of the report.

The Training Exercise Support System

The support system for future command group training will need to include an intelligent training system that provides a synthetic exercise environment to support individual through multi-echelon unit training, and to support training using remote hand-held devices and PCs along with training using the actual operational equipment of the FCS platforms. It will need to employ the global information grid, and will need to be an integral component of the FCS "Total Performance System of Systems." This section will propose and describe such a system which we have termed the Training Exercise Support System (TESS).

As shown in Figure 6, the TESS is designed to be one part of the FCS Training Support System which, in turn, is one part of the Total Performance Development System. The future Army should attend just as much to personnel selection and integrated performance support systems as it does to training and training support. Training should not be the automatic solution of choice to existing or anticipated performance deficiencies since it is frequently the most expensive and least efficient option. When possible, personnel should be selected who already possess required skills and knowledge, and systems should be designed to provide maximum performance support in the form of embedded help, intelligent agents, and other methods that will become increasingly possible in the future. When training is the solution of choice, there will be a variety of systems that make up the total training system. Institutional training will continue to be important as will distance learning, information repositories such as the General Dennis J. Reimer Training and Doctrine Digital Library (RDL), and CTCs including the National Training Center. A system like the TESS proposed here will play a major role, particularly in training collective tasks.

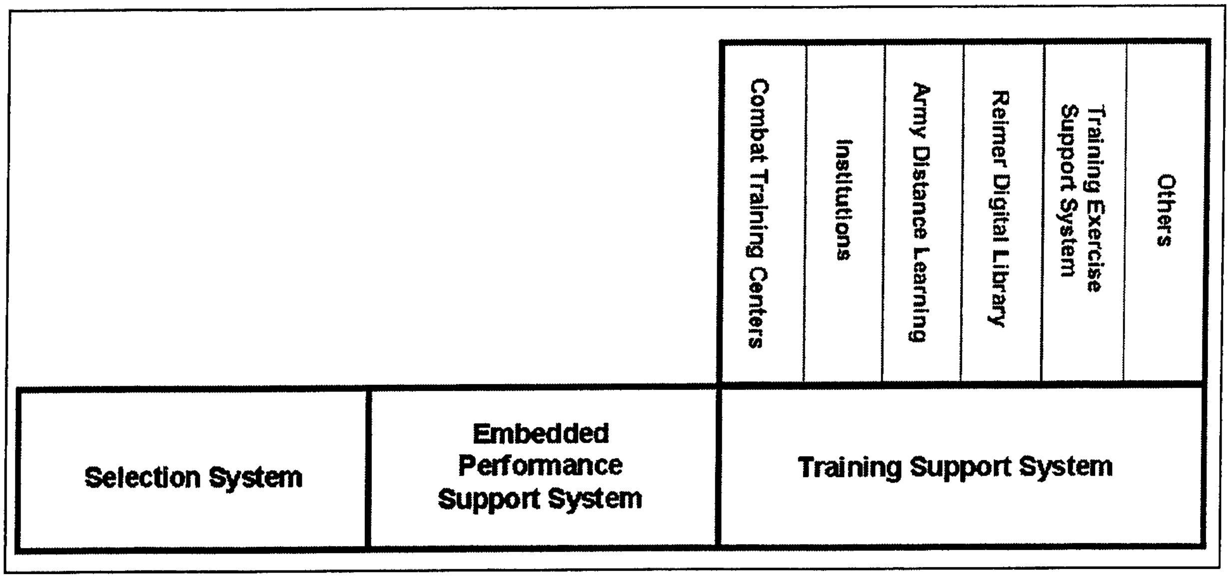

Figure 6. The total performance development system.

The TESS will be designed as an intelligent system that will satisfy the requirements for future force training described previously. It will:

- Utilize the FCS C4ISR network as its backbone.
- Support training anywhere anytime.
- Support training by all, or a subset, of the members of a unit. It will automatically detect and simulate the actions of unit members who are not actually participating.
- Support access to training from multiple sources from hand-held devices through actual operational systems.
- Support multi-echelon unit training.
- Support individual training as if participating in a collective exercise.
- Support mission rehearsal and training while deploying and during deployment.
- Support task-based and competency-based training.
- Support a gated training strategy.
- Support joint/combined training.
- Provide sophisticated AAR and other feedback systems including the ability to record unit and individual performance for future replay.
- Provide for user- or unit-based modification and creation of exercises.

The Training Exercise Support System Components

The TESS will consist of two components: a centralized component and a platform embedded component. As depicted in Figure 7, the centralized component will include the complete capability to present and support exercise execution. It will consist of the necessary hardware and software to provide exercise control, training management, C4ISR stimulation, and a multi-level observation and feedback system. It will utilize reconfigurable workstations similar to those employed in current fixed simulation sites to provide control of computer generated forces and AAR functions, and it will be accessible via the global information grid, which will also provide the capability to link multiple TESSs. In the near future, up through 2008, the TESS centralized component will probably be a relatively small and limited system capable of supporting the collective training requirements of a UA Battalion. It will consist of necessary computers, workstations, communication equipment, and support personnel, and it will probably be mobile so that it can be moved with the unit when the unit is deployed. As technology advances, the TESS could become a single system that is part of the global information grid capable of serving the collective training needs of the entire force or a major command, although this is probably not going to occur by 2015.

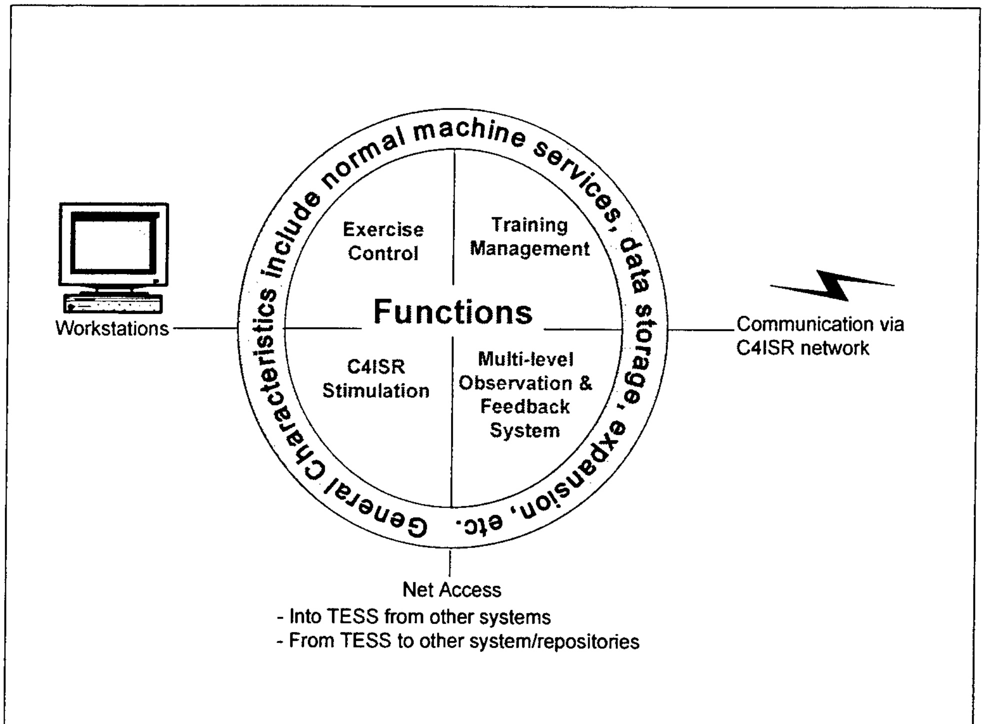

Figure 7. The Training Exercise Support System (TESS) – Centralized Component.

The second component of the TESS consists of the component that is embedded in the FCS platform as shown in Figure 8 (where the platform is represented by the support environment.) This will be referred to as the platform embedded component and consists of onboard hardware and software necessary to replicate the vehicles' functions and those of their subordinate

elements including vehicle movement.[18] The platform embedded component provides the vehicle the capability to replicate its own actions and those of elements it controls through a semi-automated force (SAF) functionality.[19] It provides communication via the C4ISR network. It does not, however, simulate the crew member's support environment functioning since the TESS will utilize the actual support environment just as it would be used in a real operation. Exercise participants will not be able to distinguish between real operations and training (other than having "told" the vehicle that it is in training mode by means of some kind of software or hardware switch, and possibly some distinctive visual cue.) It is important to remember that the TESS is both components which are in constant communication with each other, and both are essential to its operation.

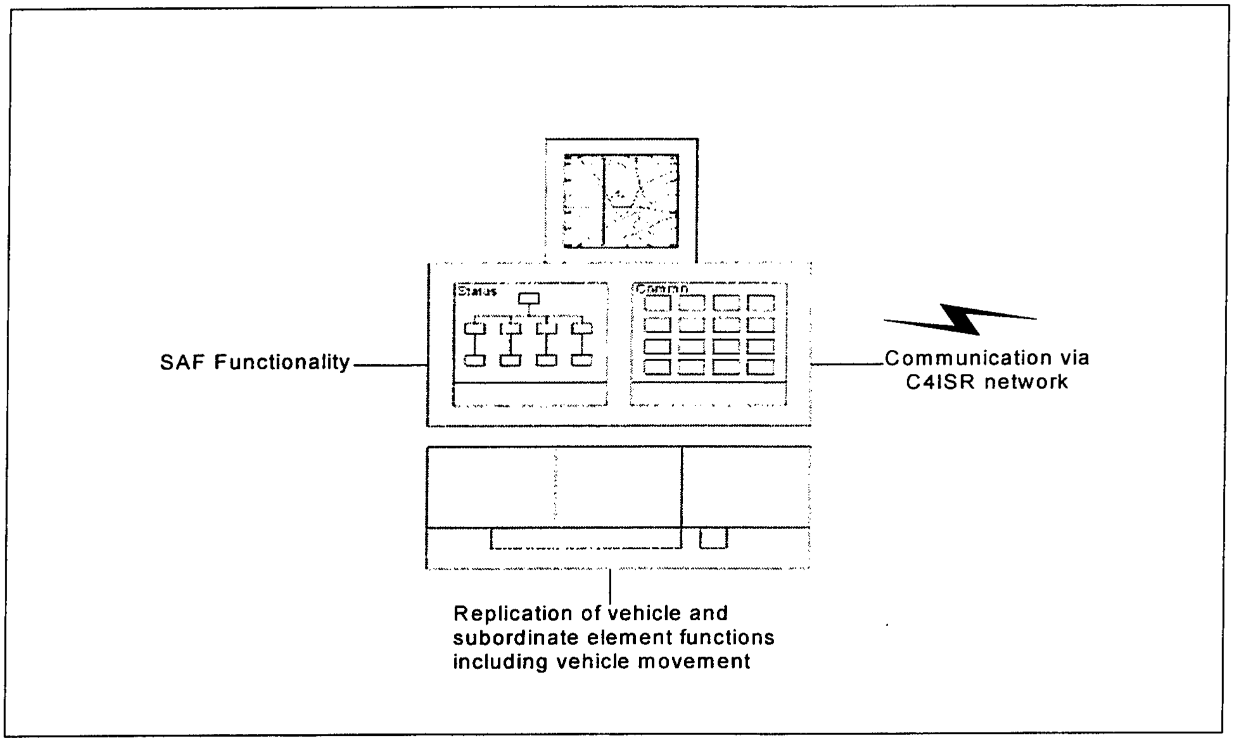

Figure 8. The Training Exercise Support System – Platform Embedded Component.

The Training Exercise Support System Functions

As touched on briefly, the TESS will have all of the functionality required to manage and deliver training exercises. Primary TESS functions are examined in detail below.

Exercise control. The TESS will have complete capabilities to initialize and support simultaneous exercise execution. Each exercise will have a corresponding initialization file

[18] This refers to representations of vehicle movement on tactical displays (without the vehicles actually moving.) It does not refer to apparent motion of the vehicle by crew members.
[19] Depending upon the situation, elements may be simulated by the centralized component or by the platform embedded component. In addition, elements may sometimes be real; in which case, the element itself would be sending data to the information grid.

which will specify friendly and enemy forces, terrain, starting locations, and any other data required to start the exercise. The TESS will include full SAF functionality to simulate the operation of the various entities as would occur in a real operational environment. Some of the SAF operation will be completed by the centralized component; some by the platform embedded component. In its early instantiation (2008), the SAF capability will require human intervention; however, as advances in modeling and simulation occur, along with advances in the use of intelligent agents, it is likely that most, if not all, of this capability will become automated. Since the TESS will likely have the capability to control multiple exercises running simultaneously, initially there will need to be sufficient SAF operators and workstations, as well as Observer/ Controller (O/C) workstations, to support them.

Exercise management and assessment. The TESS will have full support for required exercise management and assessment, issues that were extensively examined by Gossman, Graves, Mauzy, and Clagg (2001). The TESS will be capable of addressing all management and assessment concerns described in that effort. It will support exercise modification and creation by unit training personnel by including an exercise-authoring tool similar to the CITT. It will support exercise assessment by collecting data on unit performance during execution as well as unit subjective reactions to the exercise. It will include a repository for retaining these data for dissemination via the global information grid. It will provide access to a central repository of exercises for download and execution (and probably some limited repository for storage of frequently executed exercises.) It will also provide access to other resource repositories such as the RDL, the Center for Army Lessons Learned, and other relevant sources. It will support the use of core sets of exercises along with the use of gate sets. Core sets are made up of a group of exercises that serve the basic training needs of a unit. Gate sets consist of exercises that must be completed to a specified performance level in order for a unit to be rated proficient or to proceed to the next training level.

C4ISR stimulation. This represents one of the most important functions of the TESS in being able to provide training that utilizes actual operational systems. The TESS will have the capability to replicate all of the data streams required to realistically portray actions and operations that are occurring on the battlefield. The TESS will be able to send data to, and receive data from, the global information grid, or it will have the capability to fully simulate the operation of the grid itself, thereby making the data available to C4ISR networks.[20] For example, when a UAV (simulated) is deployed during an exercise, the TESS, either in the centralized or platform embedded component, will simulate the sensor's operation and will produce precise replications of the data that the sensor would send to the global information grid in real operations. All users with access to the grid will be able to receive the data on their operational support environments. All actions users take using their support environments will

[20] Simultaneous support of multiple exercises raises the question of how this will be accomplished given that there will be only one C4ISR network with the TESS interacting through it, or perhaps someday becoming part of it. One way to accommodate multiple simultaneous exercises would be by providing TESS the capability to establish training networks that filter sending and receiving of data to those individuals and systems participating in the exercise. Thus, for example, if two Platoons were both conducting different exercises, TESS would establish separate information networks for each exercise such that the first Platoon only "sees" data related to its exercise, and the second Platoon only "sees" data related to its exercise. It should also be possible to establish higher level networks such that personnel from the Platoons' commanding Company could observe both exercises. In theory, there should be virtually no limit to how many networks could be established.

be interpreted by the TESS to replicate the data that would be produced in an actual operational environment. In effect, the support environment will look, act, and feel exactly the same to the user whether he is in training or in combat.

Multi-level automated observation and feedback system. The TESS will have a number of capabilities related to observation and feedback. It will have extensive recording capabilities to support feedback and AARs. It could, if desired, be designed to record every action taken that results in data replication. It's just a matter of sufficient processing capacity. By 2008, and certainly by 2015, storage capacity will not be a concern. Because the TESS will be accessible via the global information grid, it will have the capability to allow for observation and feedback from a variety of devices and by individuals who do not need to be physically collocated at the TESS, or even with the training unit. For example, an individual unit commander could ask a mentor to observe his unit's performance, even though the mentor might be located on another continent, and the mentor could "log in" to the TESS via the global information grid, observe the exercise, and provide feedback.

One observation and feedback capability that would be highly desirable, and that may be possible in the future, is the ability to provide real-time intervention to some participants without disrupting the execution of the exercise. If an observer (or an intelligent agent) detects that some members of the training unit have performed actions that are so incorrect and off target that the unit will get no value from the rest of the exercise, the exercise could be halted for that group only, with the TESS assuming their role via SAF. They could be provided with constructive feedback to the point where they are ready to resume, at which time they would again "go live." This capability provides two major advantages over waiting until the exercise is completed. It provides immediate feedback which is likely to be more effective than feedback given after some delay. And it avoids the possibility that while the group is "doing all the wrong things," they may also be learning actions that might actually be detrimental to desired task performance. On the other hand, there are numerous obstacles that will need to be overcome for real-time intervention to become a reality. The rest of the training unit, those for whom intervention is not being provided, either should not be able to detect the change from live to SAF, or the change must occur in such a manner as to provide minimum disruption. This will require an intervention agent that is able to provide a seamless transition from the incorrect actions the group was taking to a path that will get them back on track. It will also require some means to inform the group for whom the intervention occurred what has transpired during the intervention and allow them to seamlessly resume their participation. These are by no means trivial tasks and will require significantly more intelligent agents than are currently available.

Fielding the Training Exercise Support System

As indicated previously, initially the TESS could be fielded to UA Battalions in a configuration that allows it to be moved as the battalion moves. It should be capable of supporting multiple exercises at Platoon and/or Company levels, or of simultaneously training the entire battalion. Multiple TESSs could be linked to support multi-echelon training above battalion level. And, since the TESS will use common simulation protocols based on High Level Architecture (HLA) or its successors, it will also support joint and multi-national training with other Services and other nations utilizing their own version of a TESS.

The TESS should also be fielded to the CTCs. The TESS will have the capability to support exercises that combine live and simulated training through the operation of the C4ISR systems. That is, units that are participating in a live training exercise could also be receiving C4ISR data from simulated units via the TESSs data replication function. This function would occur seamlessly to the point that the training units should not be able to identify who is live and who is simulated. This may, in fact, be one of the TESSs most important functions since it will allow execution at the CTCs of exercises that include more units than the CTC can accommodate geographically.

There are additional significant reasons for fielding the TESS to the CTCs. One stems from the fact that while UA forces will be able to train anytime anywhere on operational tasks using the TESS, this simulation training omits the training of CSS systems, movement to and from the battlefield over long distances, and having small groups functioning effectively as part of larger formations while spread out over great distances. These types of training can only occur in a field environment that supports the execution of continuous operations with units operating over doctrinal distances against realistic opposing forces. While the TESS provides much of this in any setting, it cannot replicate the wear and tear on equipment and personnel that live training can. The use of CTCs for live training will always be necessary and may well be the most effective way to stress units, systems, and personnel, and to introduce realistic friction and fog of war.

Staffing requirements for the TESS will initially be significant. Each TESS may support a number of reconfigurable workstations for exercise control and observation/feedback – perhaps as many as ten or more. These workstations could be staffed either by unit personnel or by others. On the other hand, it is anticipated that the TESS will be in-use nearly all the time since as much as 80% or more of a unit's time will be spent training. This will justify the cost. It is also anticipated that staffing requirements will be reduced significantly over time as more of the exercise control and observation is assumed by intelligent agents. By 2015, when the TESS could become a component of the global information grid, where one TESS might serve the training needs of an entire command, total staffing could be even further reduced, although there will likely be some centralized staffing.

Exercises Training Exercise Support System Supports

The project staff identified the exercise types shown in Table 2 which could be supported by the TESS. These will be discussed briefly even though the main focus of this report is on command group training. One characteristic of each of these exercise types is that it can be executed in the actual equipment or platforms versus in a simulated environment. A second characteristic is that the exercise can be conducted by the command group only, or by the entire unit. The former are termed "command group" exercises; the latter are called "manned" exercises. Finally, a distinction is made between exercises based on the echelon at which it is conducted, UA Platoon, UA Company, UA Battalion, or multi-echelon, producing the exercise types illustrated in Table 2.

Table 2

Exercise Types Developed for the Training Exercise Support System

Exercise Type	Description
PCX	Unit of Action (UA) Platoon Command Group Exercise
PMX	UA Platoon Manned Exercise
CCX	UA Company Command Group Exercise
CMX	UA Company Manned Exercise
BCX	UA Battalion Command Group Exercise
BMX	UA Battalion Manned Exercise
MCX	Multi-echelon Command Group Exercise (Battalion and Company; Battalion, Company, and Platoon; Company and Platoon)
MMX	Multi-echelon Manned Exercise (Battalion and Company; Battalion, Company, and Platoon; Company and Platoon)

So, for example, a UA Platoon command group exercise would be developed to train the members of the command group in the collective command group tasks previously discussed. Similarly, the UA Company and UA Battalion exercises would be developed for those echelons. Multi-echelon command group exercises would train command group tasks from more than one echelon in a single integrated exercise. Manned exercises are a slight misnomer in that all of these exercises are manned or staffed. However, the term is used here to indicate that all of the members of the unit may be participating in the exercise, not just the command group. As with the command group exercises, manned exercises can be conducted at a single echelon or can combine multiple echelons in the same exercise.

The exercise types shown in Table 2 provide a basic shell that allows for an entire progression of training. Platoon command groups can train by themselves; they can train with Company command groups; and they can train with Company and Battalion command groups. Similarly, the whole Platoon can train by themselves or with the Company and with the Battalion. At the other end of the continuum, individuals or small subgroups can train as if all unit members were present.

Using the Training Exercise Support System to Train

Having examined the TESS conceptually along with its various components and functions, it will be helpful to look at some examples of how the TESS could be used to support training for individuals and teams. These examples are based on a conceptualization of the TESS as it could function in the early stages of Objective Force development – the 2008 timeframe. Most of its functionality is external to the vehicles themselves, and it requires support in the form of SAF operators and O/Cs. Further in the future, as modeling and simulation technology advances, and as the capabilities of intelligent agents and the use of artificial intelligence improves, the need for human intervention will decrease, and it is likely that more and more of the TESS functionality will be embedded in the FCS platforms. It may, in fact, be possible to build all of the TESS

functionality into the C2Vs. Units might carry a complete exercise support and simulation capability with them at all times making the concept of training anytime anywhere even more of a reality. Any number of units could participate in an exercise simply by virtue of having the global information grid serve as the backbone network for sharing C4ISR data streams (as it will in the operational environment.) Even in this scenario, however, there will continue to be a need for a centralized TESS, probably as a component of the global information grid. This centralized component is necessary to support an individual or group training collective tasks as if they were in vehicles. If Captain Jones, for example, wants to "brush up" on some collective tasks by training from his home, he may not be able to access his C2V to support that training. It may be powered down and sitting in the motor pool. However, he will always have access to the centralized TESS, and by telling it what exercise to run and the role he will play, he can train on virtually any task and at any time he wants to train, although probably not with the same fidelity as training on the actual platform.

Figure 9 illustrates an example in which a UA Platoon command group is training command group tasks while in the C2V. The members of the command group are each seated at their workstations using their unique support environments. The C2V platform has been placed in training mode and is "connected" to the TESS via the C4ISR network. The exercise has been initiated by the centralized component, and the support personnel needed to control SAF entities and to provide feedback are in place. As the exercise runs, the members of the command group complete their actions using their vehicle's operational equipment exactly as they would in an operational environment. The outcomes of their actions, however, are communicated to the TESS which simulates the corresponding results and produces corresponding data streams.

As the illustration shows, the TESS centralized component, through its SAF functionality, replicates the actions of all manned and robotic entities involved in the exercise except for the UA Platoon command group. If a command is sent to one of the NLOS platforms, for example, the TESS replicates its actions as well as the results of those actions. It then creates the data streams necessary to stimulate the C2V C4ISR network. From inside the C2V, everything "looks" real.

In addition to controlling the exercise and replicating the actions of any non-live entities, the TESS is also recording the entire exercise for use during the AAR. When the exercise is complete, the AAR can be provided immediately with the command group still in the C2V since the C4ISR system should be fully capable of presenting displays (including exercise playback) needed to support a complete AAR.

There are notable aspects to this scenario. First, the C2V could be virtually anywhere and this scenario will still work. It could be in the motor pool at the unit's home station; it could be on a transport plane headed toward deployment; or it could even be in the area of deployment itself. The only thing necessary is that it be able to establish the communication link with the TESS centralized component. Second, other individuals could have been invited to observe the exercise and provide feedback. They would not need to be collocated with the TESS. They could log in using the global information grid, observe the exercise, and provide feedback to the command group even though they might be on the other side of the world. Third, this could have been part of a larger exercise at UA Team, UA Battalion, or even higher. As envisioned, one

TESS could support the battalion exercise with all command groups participating, and by linking multiple TESSs, it will be possible to conduct exercises at higher echelons or with other Services or other nation's forces. Fourth, and perhaps most important, the participants need not actually have been in their vehicles. They could just as readily have participated by accessing the TESS from a device such as a PC, or, further in the future perhaps, a personal digital assistant, as long as the device was capable of simulating the support environment to some degree of realism. The participants would have no need to be collocated, and in fact, would not all need to participate. A single member of the command group could train with other members being simulated by the TESS. Obviously, in this instance, all of the exercise control and simulation would be done by the centralized component.

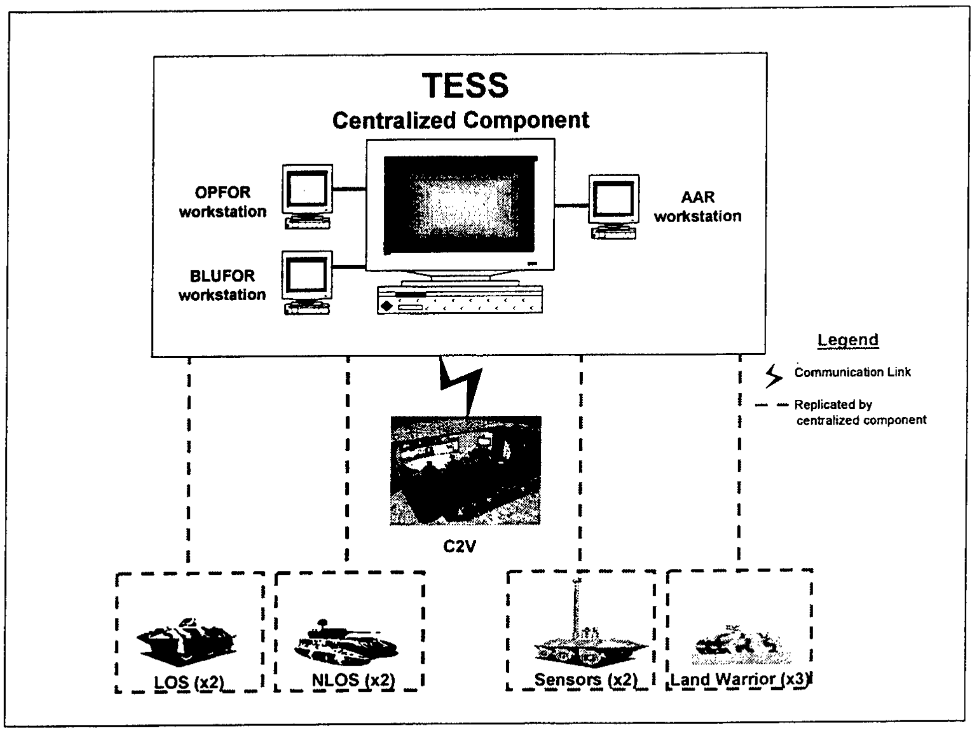

Figure 9. Example of a Unit of Action Platoon command group exercise using the Training Exercise Support System (TESS) and executed from the command and control vehicle (C2V).

A second example of training using the TESS is shown in Figure 10. In this example, not only is the command group participating, so also are the other members of the Platoon. As in the first example, they could be in their motor pool, in transport, or in deployment. The difference between this and the first example is that the actions of the Platoon vehicles are not being simulated by the centralized component of the TESS, but rather by the platform embedded TESS component. Thus, when the commander sends an order to the NLOS vehicle, the vehicle commander completes the appropriate task or tasks using his operational equipment, the platform embedded TESS component simulates the actions of the vehicle and the elements it controls and produces the appropriate results. The results are in the form of data streams that go out to the C4ISR network where all other players in the exercise, as well as SAF operators and observers, have access to them.

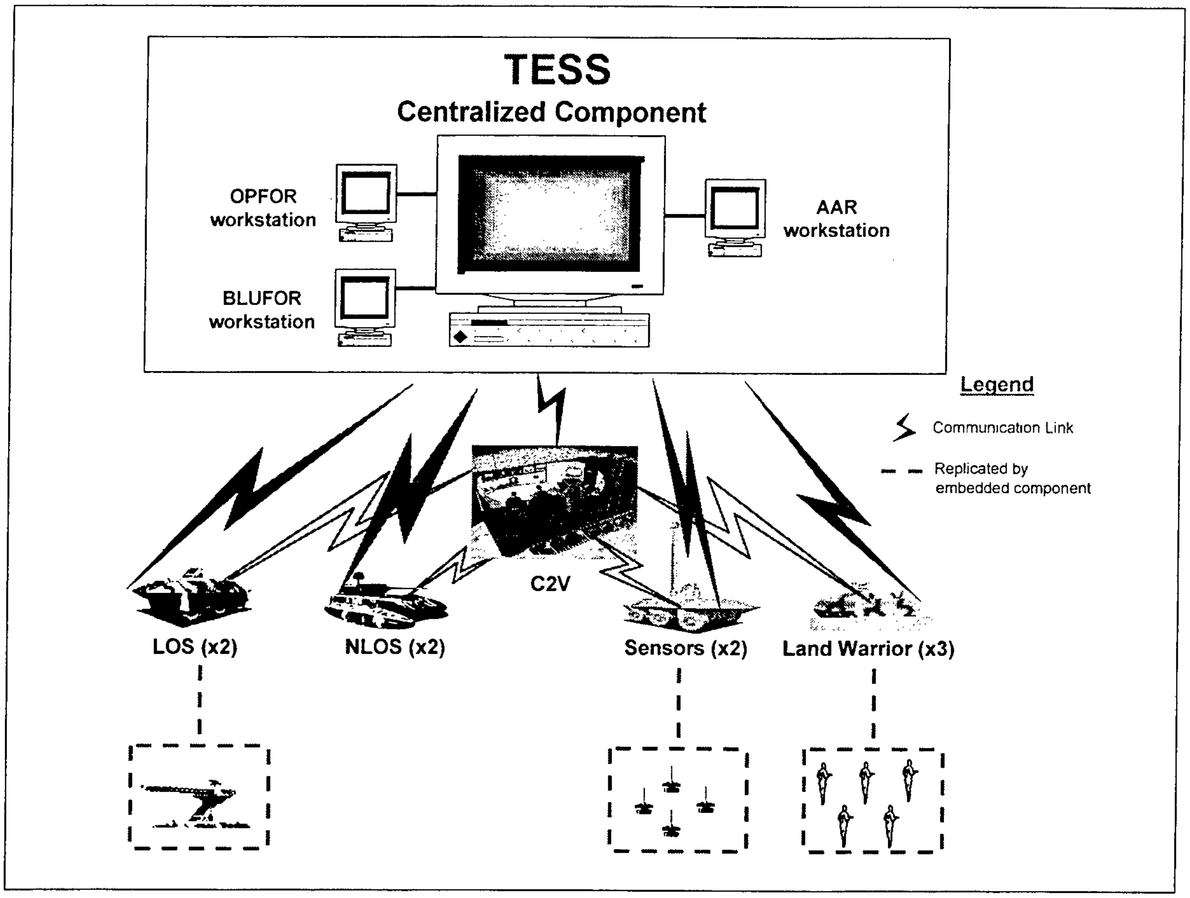

Figure 10. Example of a Unit of Action Platoon manned exercise using the Training Exercise Support System (TESS), including the centralized component, and executed from the Platoon Future Combat Systems platforms.

Figure 10 illustrates the exercise with all participants in their vehicles. However, as in the previous example, it is possible to complete this exercise with some of the players live and with some simulated. The TESS will detect the live players and will simulate the others. It is also possible to complete the exercise with some participants in their vehicles and others using PCs or other devices, or even with all players participating via remote devices. It could easily be part of a multi-echelon, joint, or multi-national exercise. The TESS will support the entire continuum of possibilities since it is operating and interacting with exercise participants by means of their support environment or some replication of it. Much of this should be possible by 2008; it should be fully possible by 2015 or 2020.

Figure 11 illustrates how TESS could support limited training and mission planning and rehearsal in the near-term (2008). The embedded platform component of TESS will include some limited exercise control, probably housed in the C2V, and each vehicle will have the capability to represent, through SAF, its operations and that of its elements. This is sufficient to support mission planning and rehearsal in theater. The Platoon will be able to run exercises that match the terrain in which it has been deployed and the missions it will perform. Since the centralized component is not involved, and since the platform embedded component will have

limited capabilities in the near-term, there may be some loss in fidelity or other limitations on exercise execution. However, there will be a significant improvement over what is currently available with legacy forces.

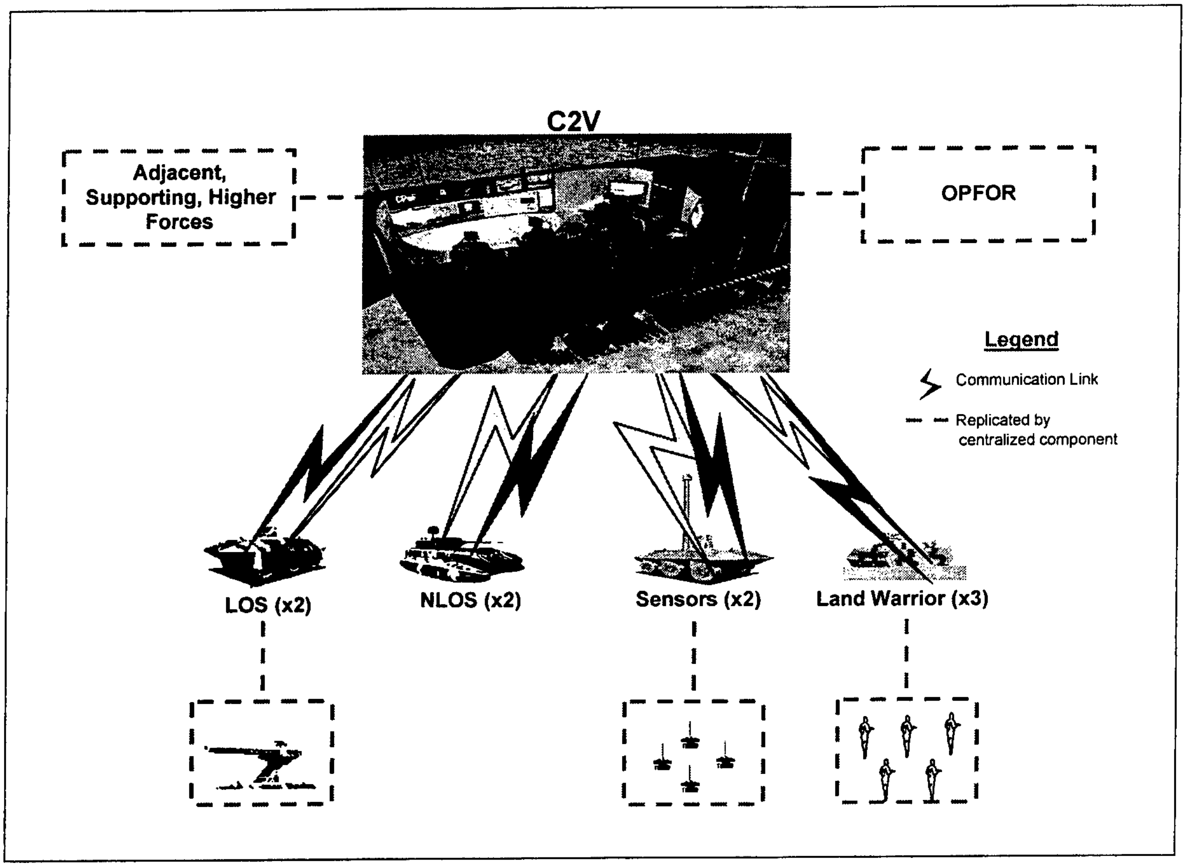

Figure 11. An example of a Unit of Action Platoon manned exercise using only the platform embedded Training Exercise Support System capability to do mission planning and rehearsal.

Implications and Benefits of the Training Exercise Support System

There are a number of implications and benefits related to the exercise support system requirements being proposed:

- It definitely supports the Army's training philosophy of train-as-you-fight. Since it employs the actual equipment that will be used in the operational environment, all cues and responses are completely realistic. And, since a major component of future operations will be information-based, the capability to faithfully reproduce that information will add sufficiently to the realism of the training. Even when exercise participants are training using PCs or other devices not based in their vehicles, training will still be as realistic as the ability to simulate the C4ISR environment. In the future, as display technologies advance, that capability will increase significantly.

- A related implication stems from the likelihood that the device that an exercise participant would use when not in his vehicle will actually be a component of the vehicle's C4ISR system. That is, there will be a portable component, such as a portable PC or a personal digital assistant that will dock with the C4ISR when the user is in the vehicle, and that the user will remove and take with him when he is not. By using an actual operational component, exercise realism will be increased.

- While the TESS does not preclude "out-the-window" viewing capability, it is not necessary for conducting the kinds of command group exercises discussed above. In effect, "out-the-window" equates to utilizing the support environment since command groups and vehicle commanders will be primarily engaged in tasks that involve processing information and issuing commands from their support environment using the C4ISR network. And, the information that appears on the support environment will be virtually identical to that which will appear in an operational environment. On the other hand, there may be other reasons for "out-the-window" capabilities such as driver training and crew training. These definitely need to be examined; however, they fall outside the scope of this report.

- The TESS will support maximum collective training opportunities. Since command groups and crews will train in their own vehicles, and since the TESS will be available to them virtually all the time, there is no reason they cannot train virtually all the time. There will be no need to schedule training at a fixed simulation center months in advance, or to have access to such centers only once or twice a year. The project staff is convinced that a standard of 80% of a unit's time being spent training is a realistic goal.

- The TESS will significantly enhance any live training the unit conducts. Live training will continue to be a very important component of the whole training picture; however, it will no longer be limited by the size of the CTC. Through the TESS's capability to simulate higher and adjacent elements, or to link to those elements which could be located at another CTC, realistic training will be possible in a live environment even given the increased footprint of the UA echelons.

- The TESS will support enhanced feedback and AAR capabilities. Trainers will be able to designate specific tasks to focus on and establish methods for measuring task performance. Also, any number of people will be able to observe an exercise as long as they have been provided access to it via the global information grid. This will allow commanders and other unit personnel to request feedback from mentors and other experts. Since the TESS will be capable of recording the complete exercise, and since the embedded component of TESS will allow playback capabilities, feedback can be provided immediately upon completion of the exercise no matter where the people providing the feedback are located. Feedback can be given immediately and constructively, thereby increasing its effectiveness. In addition, in the future, the TESS will support the capability to perform constructive intervention when necessary. Thus, if a group or individual is doing something that is so far off as to preclude getting any real value from the training, observers (or intelligent agents) could intervene while the TESS assumes their role in the exercise so that other players can continue uninterrupted.

- The TESS supports the ability of individuals to train as if they were participating as part of a group. They can access the TESS, specify an exercise to run, and participate in whatever role they choose. Alternatively, they can access the TESS, determine what exercises are already running and which roles are being simulated, and join the exercise in progress. This truly allows training anytime anywhere with maximum benefit.

- The TESS will include an exercise creation and modification tool allowing unit commanders and others to customize their training to fit their specific needs. The work that has been completed with the CITT can serve as the prototype for this function.

- The TESS will be part of the larger Objective Force Total Performance Development System, and thus, will operate in conjunction or coordination with other training efforts such as individual training using distance-learning techniques. It will provide access to repositories of exercises thereby increasing those that a unit has to choose from. It will also allow inclusion of exercises that a unit produces in the repositories for use by other units.

- While this report has emphasized command group training, the TESS should be equally effective in supporting other collective training exercises. There may, however, be a need for some additional simulation capabilities to support operational tasks that are not included in the command group training requirements.

Future Research and Development Directions

Transformation of the U.S. Army to an Objective Force fielded with FCS is an ambitious undertaking involving numerous research and development (R&D) requirements. Appendix D lists selected R&D issues for the Objective Force, with an emphasis on command group training issues that are the topic of this report. The issues in Appendix D are organized by doctrine, training, leader development, organization, materiel, and soldier systems (DTLOMS) areas, although many of them are inter-related and may fit under several DTLOMS domains. For example, issues relating to information displays apply to doctrine, training, materiel, and soldier systems; in fact, such issues are so ubiquitous that one could argue for information being an additional DTLOMS domain.

Regardless of how they are organized, the issues listed in Appendix D provide fertile ground for future R&D. This R&D needs to be initiated very quickly if an effective Objective Force is to be fielded within the present decade. The remainder of this section discusses a few key training-related R&D issues in further detail, followed by a discussion of near-term considerations for addressing them.

Key Research and Development Issues

Many of the key R&D issues of interest here center on providing embedded training and performance support for the Objective Force. In order to provide the required training for a ready Objective Force, the Army will need to implement fully the policy in effect since 1987

(DA, 1987) identifying embedded training as the preferred approach for incorporating training in the development of materiel systems.

Objective Force units will be expected to deploy rapidly to address a wide range of contingencies. As suggested earlier in this paper, their normal mode of operations will be to train 80% of the time to maintain a high state of readiness. But they cannot be expected to be fully trained all the time on every individual and collective skill that may be required for every mission. They will need to accomplish mission-specific and probably refresher training "just in time" immediately before and during deployment. Thus, they will need the capability to train anywhere, anytime.

It is impossible to specify which skills and tasks Objective Force units and individuals will need to train on just before and during deployment. Given skill and knowledge retention problems that will always exist, all skills will require retraining at some point in time. Also, Objective Force teams may be somewhat ad hoc in nature, consisting of individuals from different units who may not have had the same training experiences. One cannot assume that Objective Force teams will have a common foundation of individual and collective training experience for the skills they need to perform. Thus, Objective Force units will need the capability to train on anything anywhere, anytime.

The requirement for Objective Force units to train on anything anywhere, anytime leads to the conclusion that which Objective Force skills and tasks should be trained through embedded training is not a key R&D issue. Rather, the key issue is how to train *all* skills and tasks (individual and collective) through embedded training as effectively as possible. It is expected that some Objective Force training (e.g., individual skills training requiring high-fidelity simulations such as platform driving) can be accomplished better, cheaper, or safer in a classroom or fixed simulation facility setting, and some training of this nature will always be a wise alternative to have available. But such training is not the preferred alternative; embedded training comes first. An R&D program is needed to ensure that all training for the Objective Force is developed in an embedded form as fully as possible.

Given that the primary means of training delivery for the Objective Force will be embedded training and that this training must be deliverable during deployment, the primary delivery media will be ones units deploy with. In addition to operational equipment and networks, this includes small devices that can be carried easily, such as wireless electronic notebooks. It does not include simulators and large simulation facilities. Such facilities may be preferred for safe training of certain tasks prior to deployment, but they should not be a high priority for supporting training of Objective Force units. All training for the Objective Force should be designed and developed so that it can be delivered as fully as possible on each of two primary media: operational equipment and networks, and small wireless electronic devices. This leads to R&D issues relating to how training can be designed to be as effective as possible on these media, as well as to how training components (or objects) can be tailored or packaged automatically for optimal delivery on the media available.

The primacy of embedded training for the Objective Force means that the C4ISR network will be the backbone of training as well as operations. This network must be designed so that it

can be used to update and deliver training materials, as well as to manage and monitor training in support of providing guidance and feedback. A key consideration in the present report is that this network will be used to support collective training of teams as well as training of individuals. This leads to the need for a support system such as TESS described earlier in this report. Simulations for the Objective Force must be built into and executed within operational C4ISR networks, as well as within interconnected wireless devices (which may be ports unplugged from C4ISR networks). There are a host of R&D issues here, such as location and resourcing of TESS (see Appendix D).

A final general point on training R&D for the Objective Force relates to the need for integration or blending of training and performance support (Department of Defense, 2002). Training has generally been thought of as formal instruction that is provided in a classroom or through dedicated media. Performance support has generally been thought of as job aids and other tools that are provided on operational equipment as a task is being performed. The help routines available during use of most computer software packages are an example. These distinctions will blur as training is developed for the Objective Force. Individuals, teams, and units in the Objective Force will need to have immediate access on their operational weapons systems and networks to the current version of all training (including entry-level individual training) and performance support tools for all tasks and skills. The primary requirement is to support Objective Force soldiers and teams in performing a broad range of tasks quickly and completely while minimizing sensory, cognitive, and physical demands on them. This requires a broad integrated view of training and performance support. It also raises a multitude of R&D issues. For example, a soldier (or a team) will not want to deal with an annoying icon (like a paper clip) or a recommendation to complete a training module in the middle of performing a combat operation. He will rather want immediate help in performing the task at hand, and if he doesn't get that he will want to be left alone. Integrated training and performance support must be sitting transparently in the background and be immediately useful, readily available, and tailored specifically to the need at hand. The contents of such support and the methods for presenting it efficiently in readily understandable forms are significant R&D challenges.

Near-Term Research and Development Considerations

The purpose of this report is to describe requirements for future training of Objective Force teams, and to lay out a general approach for meeting these requirements. There is no intent to lay out a complete supporting R&D program here. However, it is possible to discuss some considerations for initiation of R&D in the near term.

The Objective Force is currently in the conceptual stage, and it is difficult to develop training for conceptual entities. But if the training R&D community waits for the Objective Force and FCS to reach an advanced state of doctrinal and materiel development before training is addressed, it will be too late to embed integrated training and performance support. It is apparent that for embedded training and performance support to be fully successful, it must be accounted for in the earliest stages of system design. The future training requirements must be identified so that a sufficient infrastructure is designed for meeting them. The collective tasks and general training requirements described in this paper are one starting point. An ongoing effort of the DARPA with support from ARI at Fort Knox is attempting to identify Objective

Force command group functions based on observation of early warfighter-in-the-loop simulation runs. Opportunities such as this should be taken advantage of whenever possible. Objective Force functions and tasks, and thus training requirements, need to be identified quickly in as much detail as possible and then refined as Objective Force systems are developed.

It is often difficult for people to think about use of new technology in the abstract. They need something they can get their hands on. Similarly, it is difficult to conduct training R&D for the Objective Force in the abstract. A representation of Objective Force operations and functions is needed, even if it is only a best guess. There will be many modeling and simulation efforts ongoing to support development of the Objective Force over the next few years. These will generally be large-scale exploratory efforts in which variables are not manipulable in a rigorous fashion to support R&D on specific training and performance support methods. Small-scale controllable representations or demonstrations of Objective Force activities are needed to support research on alternative methods for training their performance.

A near-term approach for conducting research on training and performance support for the Objective Force, currently being applied by ARI at Fort Knox, involves the development of small-scale representations of selected Objective Force functions. These may include tactical scenarios or vignettes driven by the OneSAF Testbed Baseline (OTB) or similar software. Embedded training and performance support will be integrated within these representations from the beginning to address the complex issues in that area. The functions addressed initially will fall within the C4ISR arena (e.g., future equivalent of IPB, seeing the battlefield), since that is a critical set of functions for Objective Force performance and training.

The R&D opportunities outlined above should support refinement of identification of selected Objective Force functions or activities, along with development and refinement of techniques for embedding integrated training and performance support. In the future, opportunities may allow researchers to address follow-on issues such as management and tailoring of collective exercises and perhaps performance support through a system such as the TESS. A "micro" R&D approach is just a part of the total effort needed to develop an effective training and performance support system for the Objective Force. Other parts include continued observation and documentation of modeling and simulation activities to identify Objective Force training requirements, and full incorporation of training developers and researchers early in the development of FCS. These activities should lead to increasingly specific and useful guidelines and methods for providing fully embedded training and performance support for Objective Force units.

Summary

This report examined team training requirements for the Objective Force focusing on the 2008 and 2015 timeframes. These dates are based on the tentative first unit equipped and fully operational status dates for the Army's transformation to the Objective Force. In examining the team training requirements, the project team focused on the command groups that will function at the UA levels–Platoon, Team, and Battalion, and on identifying the training requirements for them.

The report discussed the key differences between the legacy force and the Objective Force including the likelihood that future command groups will probably be smaller than legacy force staffs, will include vertical teams, will have new or modified performance requirements, and will be distributed during both operations and training. The role of training in the future force environment was examined, and the FCS and training requirements related to it were analyzed and described.

A training approach for developing team skills was proposed consisting of the TESS designed to provide training anytime, anywhere using the actual operational systems that future forces will employ. The TESS will consist of a centralized and an embedded component with the centralized component playing the major role in exercise initiation and control in 2008. The centralized component will be mobile and will be fielded at the UA Battalion level. By 2015, it is expected that most, if not all, of the initiation and control functions will be contained in the embedded component. There will continue to be a need for a centralized component, perhaps as part of the global information grid, in order to support training from locations other than FCS platforms. In 2008, there will continue to be a need for significant numbers of humans in the training loop acting as O/Cs and SAF operators; by 2015 these functions are likely to be handled by intelligent agents built into the TESS. In 2008, performance feedback will resemble what it is today with formal AARs delivered at the completion of an exercise; by 2015, the TESS will have the capability to provide constructive intervention as well as formal AARs. In constructive intervention, a human or intelligent agent will be able to interrupt an exercise for a subset of the players to provide corrective feedback without disrupting the exercise for other players. This will allow more effective feedback to be provided when it is most needed. Finally, in 2008, individuals will be able to access the TESS using devices such as PCs or hand-held digital assistants to conduct individual training; however, fidelity to the C4ISR displays will be limited. By 2015, the technology will have advanced sufficiently to allow access via wireless non-embedded devices with fidelity equal to that attained by the embedded equipment.

The final section of the report presented future research and development directions including near-term considerations for addressing the issues identified. Additional research questions, organized by DTLOMS areas, were included in Appendix D.

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Appendix A

Acronyms

AAR	after action review
ADLP	Army Distance Learning Program
AFRU	Armored Forces Research Unit
AO	area of operations
AOR	area of responsibility
ARI	U.S. Army Research Institute for the Behavioral and Social Sciences
BCX	Unit of Action Battalion Command Group Exercise
BDA	battle damage assessment
BLOS	beyond line-of-sight
BLUFOR	blue forces
BMX	Unit of Action Battalion Manned Exercise
BN	battalion
C2	command and control
C2V	command and control vehicle
C4ISR	command, control, communications, computers, intelligence, surveillance, and reconnaissance
CCX	Unit of Action Company Command Group Exercise
CDR	commander
CITT	Commander's Integrated Training Tool for the Close Combat Tactical Trainer
CMX	Unit of Action Company Manned Exercise
COP	common operating pictures
CP	command post
CROP	common relevant operating picture
CS	combat support
CSS	combat service support
CTC	combat training center
DA	Department of the Army
DARPA	Defense Advance Research Projects Agency
DCGS	Distributed Common Ground System
DCGS-A	Distributed Common Ground System - Army
DSB	Defense Science Board
DTLOMS	doctrine, training, leader development, organization, materiel, and soldier systems
FCS	Future Combat Systems
FM	Field Manual
HLA	High Level Architecture

IM	information management
IO	information operations
IPB	intelligence preparation of the battlefield
ISD	Instructional Systems Design
ISR	intelligence, surveillance, and reconnaissance
JCS	Joint Chiefs of Staff
LOS	line-of-sight
LSI	FCS Lead System Integrator
LT	lieutenant
MCX	Unit of Action Multi-echelon Command Group Exercise
MMX	Unit of Action Multi-echelon Manned Exercise
MSA	mission staging area
NLOS	non line-of-sight
O/C	Observer/Controller
OPFOR	opposing force
OTB	OneSaf Testbed Baseline
PC	personal computer
PCX	Unit of Action Platoon Command Group Exercise
PMX	Unit of Action Platoon Manned Exercise
R&D	research and development
RDL	General Dennis J. Reimer Training and Doctrine Digital Library
RSTA	reconnaissance, surveillance, and target acquisition
SAF	semi-automated force
SASO	stability and support operations
SOSO	stability operations and support operations
SOW	statement of work
TESS	Training Exercise Support System
TRADOC	U.S. Army Training and Doctrine Command
TUAV	tactical unmanned aerial vehicle
UA	Unit of Action
UAV	unmanned aerial vehicle
UE	Unit of Employment
UGV	unmanned ground vehicle
USAARMC	U.S. Army Armor Center

Appendix B

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Appendix C

Unit of Action Collective (Non-Command Group) Tasks

Unit of Action – Platoon
Assault
Attack by fire
Conduct a relief in place
Conduct assembly area activities
Conduct breach
Conduct compliance inspections
Conduct fire and maneuver
Conduct intelligence, surveillance, and reconnaissance (ISR)
Conduct liaison activities
Conduct presence patrol
Conduct screen
Conduct tactical movement
Conduct tactical road march
Consolidate
Defend
Establish checkpoints
Establish observation posts
Execute actions on contact
Execute convoy security operations
Infiltrate/exfiltrate
Perform deployment/redeployment activities
Reorganize

Unit of Action – Company
Assault
Attack by fire
Conduct a relief in place
Conduct area security
Conduct assembly area activities
Conduct breach
Conduct combat service support operations
Conduct compliance inspection (Search)
Conduct fire and maneuver
Conduct ISR operations
Conduct liaison activities
Conduct presence operations
Conduct screen
Conduct security drill (Withdraw/disengage)
Conduct tactical movement
Conduct tactical road march
Consolidate

Coordinate minefield clearance (stability and support operations [SASO]/stability operations and support operations [SOSO])
Defend
Execute actions on contact
Infiltrate/exfiltrate
Perform deployment/redeployment activities
Provide humanitarian support
Reorganize
Secure basecamp

Unit of Action – Battalion
Attack
Attack by fire
Conduct (coordinate) infiltration/exfiltration
Conduct a civil military operation
Conduct area security operations
Conduct cordon and search operations
Conduct guard stationary and moving
Conduct non-combatant evacuation
Conduct rear operations (based upon actual configuration)
Conduct relief in place as part of cycling process
Conduct reserve operations
Consolidate
Control dislocated civilian traffic
Defend
Occupy assembly areas
Patrol a zone of separation (Enforce peace agreements)
Provide disaster assistance
Reorganize

Appendix D

Selected Research and Development Issues for the Objective Force Organized by DTLOMS

Research and Development Issues – Doctrine

- What will be the basic doctrine enabling Objective Force units to accomplish a wide variety of missions? How will basic doctrine vary across echelons and missions? How will doctrine be developed that is applicable to a wide variety of situations (i.e., adaptable)? What are the fundamental principles, tenets, or values that must be maintained as doctrine is adapted? To what extent is doctrine situational?

- Will doctrine development become increasingly distributed as opposed to centralized? If so, how will this be managed? Who will control doctrine development (proponents, integrating centers, Combat Training Centers [CTCs], etc)?

- How will doctrine be kept up-to-date as lessons are learned in a variety of situations? How will doctrinal databases be accessed, controlled, and maintained? How will available lessons learned and other relevant information be collected and integrated efficiently from humans and sensors?

Research and Development Issues – Training

- How can all training (entry-level individual to advanced collective) be embedded in operational weapons systems and command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) networks to the maximum extent possible? How can the widespread embedding of training be made failsafe so it does not interfere with the operation of systems and networks?

- How can training be designed and developed so that it can be adapted readily for delivery on any available medium (including small wireless hand-held devices and displays within operational weapons systems and networks)? To what extent can such adaptation be automated?

- How can performance support be integrated or blended fully with embedded training so that appropriate support is available immediately to address any performance problem the operator, commander, or command group member may have (support may vary from a quick tip to a recommendation to retrain)? How can this support be made available when a performer needs it without interfering with performance or annoying the performer (mix of required and optional aids)?

- How will network training of teams be accomplished through simulations over operational C4ISR networks, allowing for team members to be at dispersed locations? How will such training be managed and assessed? How will surrounding elements (higher, adjacent, and lower) be represented? How will missing team members be represented? Can one system support training from individual to full team levels using intelligent agents?

- What training aids, devices, simulators, and simulations are needed for training the Objective Force? How can they be embedded to the maximum extent possible? Which need to be available in a standalone version as well as embedded?

- What is the appropriate training strategy for the Objective Force? How often do units and teams within units need to train together? What amount of live training with vehicles actually moving over terrain is required? What are the training gates that must be completed for certification of a unit as ready for deployment?

- How will performance measurement and feedback be supported? To what extent can provision of effective training feedback be automated through intelligent agents? What sorts of feedback techniques or displays are needed to enhance rapid understanding? How can immediate feedback be provided without degrading or interfering with the flow of an exercise? When is live feedback from a fellow human being required?

- How will the modification of exercises to meet individuals', teams', and units' needs be facilitated but controlled? Who (individual/echelon) will be allowed to modify exercises? Is there a basic certification or gate set that cannot be modified? To what extent can modification be automated? If widespread modification is supported, how will the process

and the large number of products be managed? For example, how will a unit rapidly access the exercise version most appropriate for its needs?

- At what echelons or locations will Training Exercise Support System (TESS) be located or hosted? What resources are required for TESS at various locations (e.g., CTCs)?

- What frequency of training or rehearsal is necessary to maintain proficiency for Objective Force tasks or functions?

- How can adaptability be trained? Should training be provided on common underlying principles, followed by extensive practice in a wide variety of situations? Are there other ways to train adaptability? (The same questions apply to multifunctional training.)

- What are the most efficient ways to train soldiers to perform complex tasks such as management and interpretation of large amounts of information from various sensors and displays? How do we develop the capability to see the whole, aggregating and fusing the parts?

- How will individual, team, and unit training performance data be archived and where will the archive be located? Who will have access to archived performance data? How will the passing of training gates be used to establish unit readiness levels? How can the determination of readiness be made more objective by the use of embedded training and performance measurement?

Research and Development Issues – Leader Development

- How will leaders be selected in the Objective Force? Will this selection be based on training and education, experience, performance, or a combination? What accession policies need to change to provide leaders for the Objective Force?

- How can leaders be developed rapidly, or be provided a large amount of wide-ranging experience efficiently? Will simulated exercises or vignettes be sufficient? What role will mentoring play?

- To what extent can leader development be accomplished using technology at a distance? What aspects of leader development require face-to-face human interaction?

- What changes are needed in promotion and retention systems to support future leader development? Should the "up or out" policy be out?

Research and Development Issues – Organization

- What is the most effective and efficient command group structure at each echelon? Does this structure need to be adapted to different situations?

- At what echelons (if any) is it more efficient to have a fixed command post (CP)? At what echelons is it necessary to have an identified (but perhaps highly mobile) CP at which personnel can gather face-to-face? At what echelons is the CP not an identified location, but always where the commander is?

- What is the lowest echelon of the Objective Force that is fully combined arms and self-sustaining for a major operation? How many standing types or configurations of units are needed at lower levels? How are these task-organized into non-standard units for non-standard missions?

- To what extent can and should operational and administrative functions be separated? How will deployable units be supported in administrative functions to allow training 80% of the time? How will matters such as the Uniform Code of Military Justice be handled?

Research and Development Issues – Materiel

- What capabilities must be built into operational weapons systems and networks to enable complete embedding of training and performance support (including team network training)? What resources are required to support these capabilities?

- How can operational weapons systems and networks be designed through performance or usability engineering to maximize the ease of employment? How can system design minimize sensory, cognitive, and physical demands on soldiers in order to reduce task performance complexity and time, thus reducing training and performance support requirements? To what extent should operational systems and networks have common interfaces? To what extent should interfaces be readily adaptable to individuals' preferences (e.g., through scanning of a "smart" card)?

- How can decision support and planning aids be integrated with operational weapons systems and networks? To what extent can these reduce information and options, thus reducing cognitive demands on leaders and soldiers?

- How can operational weapons systems and networks be designed to support enroute mission planning and rehearsal during deployment? How can enroute mission planning and rehearsal be accomplished with available resources (i.e., with or without operational weapons systems and networks)? How can digital terrain representations of mission areas be provided readily to support enroute planning and rehearsal? Can this include complex and urban terrain?

- How can operational networks be designed to provide continuous connectivity on the move, thus providing continuous C4ISR? How will relays be handled? How will networks accommodate missing relays or nodes?

- How can the platforms put at risk during combat be made robotic to the maximum extent possible? To what extent can robots be made autonomous? How will they be controlled? What will be the message formats for directing robots? Can they be the same as those for directing humans?

- How can maximum force protection be provided for soldiers occupying light Future Combat Systems? What materiel solutions (e.g., approach warning indicators, countermeasures) to force protection are needed to complement tactical solutions (e.g., stand-off engagement)?

- How should a common operating picture be displayed? Does this vary by echelon and mission? What are the specific information requirements for each echelon and mission? How can intuitive summary graphics be incorporated to convey knowledge readily?

Research and Development Issues – Soldier Systems

- How will soldiers be recruited or selected for the Objective Force? Are unique capabilities required? Are these available in the recruiting base?

- What measures are needed to help soldiers and their families cope with the stress and strain of frequent rapid deployments and deployment readiness as a way of life? What individual and family support structures need to be established?

- What sort of military occupational specialty and rank structure is needed to allow soldiers to be as multifunctional and adaptable as possible? Will the personnel system support soldiers being highly trained generalists who can be trained very rapidly to be specialists for a range of missions?

- Will the individual replacement system degrade performance of Objective Force teams and units? Will a regimental or hybrid system (i.e., some sort of team set fielding) be necessary?